UNITED STATES AIR FORCE GRADUATE DEGREES FROM 1990 TO 2000: A COMPARISON

THESIS

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AFIT/GLM/ENV/01M-01

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Wright-Patterson Air Force Base, Ohio

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

AFIT/GLM/ENV/01M-01

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THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

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March 2001

AFIT/GLM/ENV/01M-01

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March 1, 2001

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Acknowledgments

I would like to thank God and his Son Jesus Christ for without whom this thesis would not have been possible. I would like to thank my whole family for all their prayers, love, and support. It has been a blessing being so close to you. I would also like to express my gratitude to the following people who were also instrumental in this endeavor: My advisor Major Mark Ward for his wisdom, guidance, and encouragement throughout this whole process; Colonel Thomas Kelso for the original thesis idea; Major David Biros for his ideas, help, and thoroughness; and Staff Sergeant Gregorios Theopistos for finding and retrieving the data for this study.

Jonathan G. Downing

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Abstract

Throughout its history, the United States Air Force has been concerned with technical graduate education. In 1947, the Ridenour Report stated the importance and need of Air Force officers with technical graduate degrees. This emphasis has served the Air Force well, but there is concern among senior Air Force leaders that there has been an erosion of these technical skills and graduate education.

This research will examine the issues surrounding technical graduate education in the Air Force and will address the possible loss of such technical education. The results of this research provide specific statistical data and analysis on the types and numbers of graduate degrees achieved by Air Force line officers in the years 1990 and 2000. It will discuss the results for all Air Force line officers and will then examine specific Air Force Specialty Codes. This research will enable further investigation into the impact that graduate education will play on the future of the United States Air Force.

Based on the data analysis, this study concludes that there has been no significant change in the percentage of overall technical graduate education from 1990 to 2000. There has, in fact, been a slight increase in the percentage of technical graduate degrees in the following career fields: Pilots (11XX), Civil Engineers (32EX), Communications and Information Officers (33SX), and Developmental Engineers (63AX). All other areas examined showed no statistically significant changes.

UNITED STATES AIR FORCE GRADUATE DEGREES FROM 1990 TO 2000:
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I. Introduction

Background

Since its inception as a separate branch of the United States Armed Forces in September 1947, the United States Air Force (USAF) has emphasized the importance of educating its officers. Unites States Code, Title 10 mandates that all officers must have baccalaureate degrees from qualifying educational institutions. Throughout its history, the USAF has been led by visionaries who realized the importance of technical graduate education. Men such as Dr. Theodore von Kármán, a leading aeronautical scientist, and General James Doolittle, the hero of World War II who led the first air raid on Tokyo, extolled the virtues of technical graduate education and claimed that if the Air Force did not continue to stress technical education of its officers, it would harm research and development and the Air Force as a whole (Ridenour, 1949: VII-1).

Problem Statement

In 1995, senior Air Force leadership expressed concern that the type of master's degree achieved by officers was becoming less important and that officers were getting master's degrees to achieve rank and not for the purpose of job excellence. General Ronald Fogleman, former Air Force Chief of Staff, commented on this belief: "As a result of discussions at our November [1995] meeting with the Air Force's senior leaders,

Secretary of the Air Force, Shiela E. Widnall and I have changed the policy concerning advanced academic degree consideration by officer promotion boards" (Fogleman, 1996: n. pag.). General Fogleman mandated that the Air Force Personnel Center begin masking advanced academic degree status for the main majors promotion board beginning in 1996.

General Fogleman went on to emphasize that the type of degree was important and not just a square filler, and that the right type of degree should be attained at the right time in an officer's career: "This is in no way intended to communicate that completion of advanced degrees is not important. In fact, it actually emphasizes just the opposite—advanced degrees enhance professional development when applied at the right time for the right reasons" (Fogleman, 1996: n. pag).

Despite these efforts, concerns that the de-emphasis of technical education continues to exist remain in the Air Force today. In November 2000, Air Force Chief of Staff, General Michael Ryan expressed concerns over retaining people in the science and technology career fields. "We're eroding the high experience levels that we have in the United States Air Force in these critical areas that are required for us to remain the premier aerospace force we are today. We are going to have to work this issue very hard" (MacRae, 2000: 5).

Although these concerns of senior Air Force leadership imply that there has indeed been a loss of technically competent officers, there is no specific statistical evidence to support or disprove that belief. This research effort will attempt to clarify the true nature of technical competence in today's Air Force line officers. It will do so by answering the specific research question: Has there been a decrease in technical graduate

degrees (a definition of technical degrees is found in Chapter II) earned by Air Force line officers from 1990 to 2000? In order to account for attrition, the percentages of each year will be calculated and then compared.

Research Objectives

The main objective of this research effort is to determine if there has been a decline in advanced technical education from 1990 to 2000. Specifically, this research will attempt to determine if there has been a decline in the percentage of technical degrees of overall Air Force line officers and in those Air Force Specialty Code (AFSC) career fields where it is critical that an officer have an advanced technical degree. These technical career fields include scientists, developmental engineers, and acquisition officers (an in-depth discussion of AFSCs is found in Chapter II). Additionally, it will look at those career fields where a technical degree is important. These career fields include communications officers and civil engineers. It will also examine those officers that are or will most likely be heavily involved in senior Air Force leadership (pilots, commanders, and general officers). As stated earlier by von Kármán and Doolittle, without technical knowledge of the advanced systems and processes they are responsible for, senior Air Force leadership will be hard pressed to effectively manage and fully utilize these capabilities.

Research Question

The founders of the USAF realized the importance of technical education of its officers. These values were made clear by reports such as the Ridenour Report

(Ridenour, 1949: Conclusions 1) and letters by General of the Army and Commanding General of Army Air Forces, Hap Arnold (von Kármán, 1945: iii). The overarching question regarding this study is: Has there indeed been a decrease in the percentages of technical graduate degrees achieved by Air Force officers from 1990 to 2000? The year 1990 was chosen as a comparison because 1990 was immediately before Desert Storm. After Desert Storm was over, the Air Force began a large drawdown of its active-duty forces. The Air Force of 1990 was significantly larger (430,818 enlisted and 100,045 officers) than the Air Force of 2000 (282,345 enlisted and 69,027 officers).

In order to answer the above question, three specific research questions will be addressed. The first question is: For line officers Air Force-wide, has there been a decrease in technical graduate degrees? The second question is: For a given AFSC, is there a statistical difference between the degrees earned in each AFSC? For example, if an officer has an AFSC of 62EX (developmental engineer) is he or she more likely to earn a specific degree? Specific statistical methods used to answer this research question will be discussed in Chapter III. The third question is: Given that an officer is in a specific career field, what is the percentage of officers that earn specific degrees? For example, examining the 62E1A (aeronautical engineer) career field, what is the percentage of officers that will earn a graduate degree in aeronautical engineering versus a degree in something other than aeronautical engineering? Answering this question will give insight into how likely it is that an officer will achieve a specific degree and how that has changed in the past 10 years. For example, if the comparison of percentages from 1990 to 2000 of aeronautical engineers showed a decrease in the likelihood of them achieving an advanced degree in aeronautical engineering, this would indicate that

aeronautical engineers are getting degrees in areas other than aeronautical engineering. If the officers are getting non-technical degrees, this would lend credence to the argument that there is less emphasis on officers achieving technical advanced degrees and less emphasis on maintaining technical excellence.

Methodology

The methods used to analyze the problem will consist of two separate statistical tools: Determining the overall non-technical and technical percentages, as well as the individual degree percentages, and the chi-square test. Both methods will be applied to Air Force Personnel Center data on U.S. Air Force officers from 1990 and from 2000. The two test statistics (1990 and 2000) will be compared to each other to determine if a difference exists. The chi-square test will then be used to determine if there is a statistical significance in the difference of the type of graduate degrees earned by Air Force officers within each respective category. This test will be applied to all line officers Air Force-wide and individual AFSCs such as 61SX (scientists) and 62EX (developmental engineers). This study will examine technical degrees Air Force-wide and by specific AFSCs. It will do this by calculating the percentages for each degree for all officers and then for individual AFSCs to determine the likelihood of each degree being achieved. These percentages will describe what proportion officers in each AFSC have specific degrees. The percentages of 1990 will be compared to 2000 to determine what statistically significant differences, if any, exist.

Scope and Limitations

This research is probably best generalized to United States Air Force line officers up through the rank of lieutenant colonel in career fields that are technically oriented or those officers that will most likely be involved in senior Air Force leadership (such as pilots) and officers above the rank of lieutenant colonel (colonel through general) who are commanders or in positions of senior leadership. Those officers that either require specialized graduate and postgraduate education (such as chaplains, doctors, dentists, and lawyers), or officers in career fields that are not technically oriented, or are not in positions of senior leadership are not included in this study. The database used to pull applicable data consists of all USAF officers and is kept at Randolph Air Force Base, San Antonio, Texas. It is maintained and updated by the Air Force Personnel Center (AFPC).

There are several limitations to this study. The primary one is this study does not show causality. If this study does indeed show a shift in technical education one way or another, it will not provide the cause or causes for such a shift. The second main limitation is this study will not analyze the impact of any trends. For example, if this study shows that there has indeed been a loss of technical expertise in the form of technical graduate education, it will not address what impact this has had on the Air Force over the last 10 years nor will it address what impact it will have on the future of the Air Force. Although these limitations are substantial, the contributions to the Air Force are significant and will be discussed in the next section.

A major assumption to this research effort is the percentages of technical degrees in 1990 satisfied USAF requirements. This may or may not have been the case and this research effort does not evaluate the required nontechnical and technical levels of either

1990 or 2000. Another assumption is the percentage of technical versus nontechnical educations should not change from 1990 to 2000 as the size of the Air Force changed. This limitation is further discussed in the Recommendations section in Chapter V.

Contributions of Research Effort

Although there has been much concern and speculation concerning the loss of graduate technical education, there is no statistical evidence to support or disprove this belief. This study will provide that statistical evidence and analysis. It will provide a snapshot of graduate education in 1990 and in 2000 and will also show what differences, if any, exist. This will enable further research to determine what impact such differences may have had in the past and what impact this will have in the future. It will also provide recommendations to senior Air Force leadership concerning the effective management of technical graduate education in the Air Force.

Organization of Research

Chapter II addresses the history of technology in the USAF from post-World War II until the present. It also highlights significant contributions by Air Force officers with technical degrees. It then discusses the overall subject of R&D management and will analyze the role of technical management in today's civilian companies. Next, it discusses graduate degrees of many of the Chief Executive Officers (CEOs) of the largest government-contracting companies and also discusses the role of graduate education in the USAF. It then discusses the current Department of Defense (DoD) and USAF graduate education management systems and emphasizes the need for USAF officers

with technical education. A specific explanation of the Air Force Specialty Code (AFSC) system follows. Relating to AFSCs, the role of scientists and engineers and their position in the Air Force R&D process is also examined. Finally, it discusses specific proposals to be tested.

Chapter III discusses the hypotheses and the methodology and statistical tools used. It first discusses how the percentages of each degree will be calculated and compared. It also discusses how the non-technical and technical degrees will be compared to determine if any differences exist. It then addresses the chi-square test to determine if the differences are statistically significant.

In Chapter IV, the data and their analysis are presented. This data will be for six main career fields: 11XX (pilot), 32EX (civil engineer), 33SX (communications and information), 61SX (scientist), and 62EX (developmental engineer), and 63AX (acquisition manager). In addition, it will also examine senior Air Force leadership to include all officers above the rank of lieutenant colonel (colonel through general). For all of the above data, the years of 1990 and 2000 will be examined and compared. Chapter V addresses the specific conclusions of the research effort, Air Force implications, recommendations, and possible areas of future research.

II. Review of Literature

Chapter Overview

This chapter will trace the history of technology in the United States Air Force from post-World War II up to the present and will also discuss achievements and contributions made by officers with technical graduate degrees. Then it will examine the subject of research and development management. After that, it will analyze the role of graduate education in today's civilian companies and discuss the current topics of debate, including requirements of a Chief Executive Officer (CEO). It will also discuss the graduate degrees of many top governmental contracting companies' CEOs. A discussion of the role and need of graduate education in the USAF will follow, coupled with a detailed explanation of the Air Force Specialty Code (AFSC) system. Relating to AFSCs, the role of scientists and engineers and their position in the Air Force R&D process will also be examined. In addition, the current USAF graduate education system will be evaluated. Finally, reasons for this exploratory study will be set forth and proposals will be declared.

Background

Since the end of World War II in 1945, the United States Army Air Forces (subsequently the United States Air Force [USAF] in 1947) has been concerned with maintaining technological dominance over its adversaries. In order to maintain this dominance and ensure national security, the Air Force relies heavily on science and

technology. In November 1944, Dr. Theodore von Kármán, a noted scientist and consultant in aeronautics, was asked by General of the Army, Henry Arnold, to prepare a report on the future of Army Air Force research and development progress. In his subsequent report titled Toward New Horizons (1945), von Kármán discussed the importance of science and technology to the Air Force and outlined the scientific responsibilities of the Air Forces (ix).

Von Kármán was a great visionary whose efforts for Air Force research and development cannot be overstated. Immediately after the end of World War II, von Kármán was sent to Germany to glean technical secrets from Germany's top scientists and engineers. Discussions with these scientists and discovery of all their research materials helped the United States to develop jet propulsion, guided ballistic missiles, and the B-47 bomber (Gorn, 1992: 105).

Von Kármán felt the Air Force was primarily responsible for making sure the United States was prepared to effectively wage air combat and this responsibility lay solely on the shoulders of the Air Force. He also stressed the importance of recruiting and training people who were knowledgeable about scientific methods and had the mental capacity to operate advanced equipment. Finally, von Kármán recommended authorization of the Air Force to expand existing facilities and create new research facilities for the purposes of working on Air Force problems and issues (1945: 81).

Senior Air Force leaders did not initially heed von Kármán's words because there was no palpable threat immediately following World War II. This wavering on science and technology was also in direct conflict with the Ridenour Report, an overall study of research and development activities commissioned by Chief of Staff, General Hoyt

Vandenberg, in April 1949. Dr. von Kármán was, at the time, chairman of the Air Force Scientific Advisory Board and spearheaded the Ridenour Report. The report stressed the importance of research and development to the Army Air Force. It claimed that the quality of the Air Force in the future would be determined by research and development. It also went on to state the importance of recruiting and training personnel for research and development (Ridenour, 1949: VI-9). The Ridenour Report also emphasized the importance of technically competent officers and complained of poor retention of officers with technical skills. "The technical personnel situation in the Air Force has been deteriorating over the past few years and…immediate action must be taken to prevent the cumulative results of this deterioration from reaching dangerous levels" (Ridenour, 1949: VII-1).

Senior Air Force leaders began paying more attention to science and technology and the importance of technical skills in 1950 when the Korean War broke out and the U.S. faced a formidable adversary in the Russian-built MiG-15 fighter. The primary weapon used to counter this threat was the F-86 Sabre. Its development would not have been possible without sweepback wing technology taken from German engineers and scientists after World War II, and this caused many USAF leaders to begin to recognize the benefit of science and technology (von Kármán 1967: 304).

After the Korean War, the Cold War began in earnest, and the U.S. concentrated on developing and perfecting the intercontinental ballistic missile (ICBM) program. General Bernard Schriever, a 1941 graduate of the Air Corps Engineering School (which eventually became the Air Force Institute of Technology), was a major proponent of technical education and research and development. General Schriever commented on the

importance of officers with technical educations: "Those officers then became the cadre from which the inertial guidance systems of ballistic missile systems, and many other applications derived, including some of the space program" (Neufeld, 1993: 44).

General Schriever was appointed as the director of the ICBM program and enjoyed outstanding success with various ICBM programs. According to Boyne, "Schriever pulled off a managerial coup by fielding no less than three generations of ICBMs almost simultaneously. In addition, he instigated the Lockheed U-2 aircraft, and essentially created the managerial, engineering, and administrative basis for the U.S. space program" (Boyne, 1997: 96). The ICBM program is a prime example of effective use of research and development management. The technology was cutting edge, and it took the combination of men with technical educations and know-how, managers who realized the importance of research and development, and a willing Congress to make it a reality. It also shows the impact individual officers with technical degrees can have on advanced technologies.

During the 1960s, Secretary of Defense Robert McNamara realized the importance of military research and development and attempted to take greater control to ensure research and development was managed effectively. His moves were not well received by senior Air Force leaders. Schriever complained, "Certainly, as everyone knows, I was in complete opposition to the way in which McNamara was attempting manage R&D in systems acquisition" (Neufeld, 1993: 67). Despite this micromanagement, situations such as the Cuban Missile Crisis kept the nation focused on the importance of technology to counter the Soviet threat.

The late 1960s and early 1970s were a time of great technological change and innovation that created management problems for senior Air Force leadership. In 1968, the Air Force Deputy Under Secretary for Manpower commissioned a study entitled: Appraisal of Future Military Education Needs of Senior Air Force Officers, with the purpose "to appraise the characteristics of the environment in which Air Force officers will function during the next 20 years and to identify the new education objectives required to support career development of senior officers" (Livingston: i).

The report cited increased scientific and technological change as the reason for changing education requirements. It also discussed the future needs of Air Force leadership due to these changes: "Senior Air Force officers will need to become highly competent technical executives in order to manage the complex organizations that will evolve as the numbers and varieties of scientists, engineers, and technical specialists increase" (Livingston, 1968: c).

The 1970s saw the emergence of the F-15 air superiority fighter that was designed to counter any Soviet fighter. An Air Force officer with a technical education also heavily impacted the F-15's development. In 1965, Major John Boyd finished an engineering degree from Georgia Tech. Based on his studies there, he published a 2-volume report on energy maneuverability. This report also formalized a method for developers to directly compare the proposed designs that were competing for the F-15 contract award. Major Boyd joined the Air Staff in 1966 and was involved in the F-15 design selection. He rejected all the existing designs, and all the contractors were sent back to the drawing board. The final design was won by McDonnell-Douglas and

became the F-15 Eagle (Jenkins, 1997: 7). Since its introduction, the F-15 maintained technological superiority for approximately 20 years.

The collapse of the Soviet Union in 1991 ended the Cold War and diminished the Soviet threat, but the technology used to win the Cold War was still in the U.S. arsenal and gave the U.S. an overwhelming technological advantage during the 1990-1991 Gulf War against Iraq. Such technology included the F-15 fighter and the F-117 stealth fighter. Without such technology, it is highly likely that the U.S. would not have achieved success as quickly or with as few casualties.

Despite this technology, as early as 1985, senior Air Force leaders were noticing a disturbing trend of the de-emphasis of science and technology. General Robert March, former commander of Electronic Systems Division and Air Force Systems Command commented:

> I've seen a trend over the last 20 years or so of decreasing support to our technology base programs in the Air Force. I believe that is of critical importance. I've seen the trend; the trend exists of decreasing support to the technology base. Now it turns out that SDI (Strategic Defense Initiative) may tend to offset this problem that was, in my judgment, getting to be an acute problem. SDI technology, just by the nature of technology, will benefit much beyond its narrow purpose. (Neufeld, 1993: 84)

It is important to note that SDI was cancelled in May 1993 after the collapse of the Soviet Union and the technology was never fully investigated nor implemented (Burrows, 1997: 289).

This de-emphasis of science and technology could have influenced graduate technical education but determining the impact would be difficult. It remains to be seen if the trend of decreased graduate technical education actually exists and if it does, how it

will impact the United States Air Force and its ability to maintain technological superiority over its enemies.

Research and Development Management

Research and development (technical) management is a difficult subject to define. In addition, it involves much uncertainty and risk and is very difficult to perform well. For these reasons there has been a great amount of literature written on the subject of R&D management (Blake, 1978; Bright, 1964; Brown, 1995; Davis, 1986; Evans, 1969; Follmer, 1990; Gee and Tyler, 1967; Gibson, 1976; Glasser, 1982; Moranian, 1963; Popper, 1971; Roussel and others, 1991; Stein, 1993; Twill, 1980; Walters, 1965; White, 1975).

In his book titled Managing for Responsive Research and Development, Blake discussed the complex and diverse nature of the literature concerning R&D management. Blake felt that although there had been much written on the subject of research and development, managers still did not know how to accomplish it effectively. Blake also claimed that throughout the extensive literature, there was not one authoritative body on how to perform research and development management (Blake, 1978: vii). Although it is a very difficult subject, it is critical that the Air Force understand the various aspects of R&D development in order to maintain its technological dominance.

Since the late 1970s, civilian industry has become increasingly involved in R&D. Blake also commented on the shift from DoD research to other areas with more civilian applications: "In government activities, research and development is no longer the more or less exclusive province of the Defense Department; it is a matter for deep concern in

almost all departments and agencies" (Blake, 1978: vii). This trend will make it increasingly difficult for DoD to remain on the cutting edge of technology and research and development.

Role of Technical Education in Civilian Companies

R&D received increasing amounts of management and funding during the late 1960s. Blake discussed the impact of managerial decisions and the emerging role of R&D management: "The lessons of the era of advanced technology have made it evident that misuses of R&D can be just as damaging to the health and survival of an organization" (1963: vii).

This emphasis continued into the 1980s. According to Twiss: "No longer can R&D be regarded as a peripheral activity. It will necessitate what is now so often lacking, a closer integration of R&D with the formulation of business policy and a better understanding of the processes of technological innovation by both top management and the technologist" (1980: xxii). Since more and more emphasis is being placed on R&D, the overarching question is how to best manage R&D. This question is difficult to answer due to the uncertain nature and high risk involved in R&D.

Since the early stages of scientific management, researchers such as Henry Towne and Frederick Taylor addressed the issue of management of engineering processes (Shafritz, 1996: v). Towne proposed the following solution for a lack of good technical managers: "It [the remedy] should come from those whose training and experience has given them an understanding of both sides (viz: the mechanical and clerical) of the

important questions involved. It should originate, therefore, from those who are also engineers" (Towne, 1886: 429).

If most companies and organizations acknowledge that R&D is extremely important, why do so many companies do poorly in R&D? In a study of top company executives, Evans found that many companies were lacking in R&D compared to the other areas. "Most executives admit that their R&D is less effectively and efficiently managed than other functions such as manufacturing" (Evans, 1980: 20).

One major problem is obtaining top levels of management capable of effectively managing R&D. Marvin of the American Management Association commented that finding people who are qualified (through training, experience, and interests) to manage technical programs is extremely difficult. Marvin also claimed: "To do a good job, research managers must be competent and experienced in scientific areas if they are to execute their managerial duties effectively" (1963: 5).

Another major area of research focuses on defining the characteristics required of R&D managers. Davis claimed, "Organizations are likely to adopt innovations when they have strategies that stress technological advancement, high proportions of managerial specialists who are professionally active, and managers who value new ideas and are receptive to change (1986: 4).

One may ask the question: Do not R&D managers perform the same tasks and require the same characteristics regardless of the organization being managed? There is some debate regarding the technical requirements for managers of R&D. Gee and Tyler performed a study of managers of innovation and came up with a list of 10 qualities that R&D managers generally possess. "Our list consists of 10 attributes: integrity, scientific

credentials, intellect, foresight, interpersonal skills, imagination, analytical ability, objectivity, energy drive, and judgment" (1976: 171). The major managerial quality on this list that generates much controversy is scientific credentials. Researchers such as Brown, Stein, Twiss, and Walters agree that it is critical that an R&D manager have a technical or scientific background. They also agree that managers that do not have technical backgrounds will have a more difficult time being effective research and development managers. Twiss states such a view when he wrote, "Non-technological managers experience difficulty in understanding the professional orientation of the research worker. They may attempt to change it, although if successful, the change may not always be in the company's long-term interest" (1980: 179).

Brown also counters the view that scientists and engineers cannot make good managers: "The fact that many engineers and scientists, especially some who start their own companies, become great managers is ample proof that technically educated people can acquire the skills necessary for technical management" (1995: 4). Brown also questions the technical management abilities of those managers trained in business administration: "Some business students schooled in management and human interrelationships still fall flat on their faces when trying to manage technical people" (1995: 4).

Roussel disagrees with this view and points to various successful companies that were heavily involved in innovation and R&D who were lead not by managers that possessed scientific backgrounds but possessed good business and managerial skills. Roussel stated:

> Do not conclude from my comments that my executive capabilities are limited by my lack of technical background. Let me remind you that James Webb, Kennedy's head of NASA in the 1960's was a lawyer. He ran one of the most complicated technological enterprises of all time, and he put men on the moon on time and on budget. (Roussel et al., 1991: 44)

Stein counters this by stating that straight business managers are a thing of the past: "The next decade will likely see the demise of the pure manager—that is, one without some detailed technical competence in his or her particular industry—and the rise of the technologist manager" (1993: 9).

Another area of debate concerns how a manager actually acquires the technical background and knowledge to perform effectively in the world of R&D. In his effort to analyze technology transfer in entrepreneurial companies, Roberts tested the relationship between education and technology transfer. He claimed: "Statistical testing supports the notion that entrepreneurs with master's degrees transferred the most technology" (Roberts, 1991: 111). Roberts was mainly referring to entrepreneurs with technically oriented master's degrees. In his final conclusions, Roberts discussed the importance that education plays for high-technology firms. "The more successful companies are primarily founded by entrepreneurs with what is labeled in the samples 'moderate educational levels', that is, not more than an MS degree" (Roberts, 1991: 274).

Analysis of Graduate Degrees

There are several master's degrees available to a manager: The Masters of Business Administration (MBA), the Master of Science (MS), and the Master of Arts (MA). There are various types of MS degrees available. The MS or MA in Management and an MS in a specific discipline (such as aeronautical engineering) are two common

types. There is much argument over which degree is best for managers of organizations that rely heavily on technology, technical processes, or R&D.

A major problem in comparing MBA and MS or MA degrees on the basis of technical management is that there is a large spectrum and type of MBAs available and not all programs are accredited. Some MBA programs, such as the Massachusetts Institute of Technology (MIT) Sloan School of Management, are very technically oriented, while others, such as the Wharton School, emphasize business and finance skills (Bickerstaffe, 1996: 296, 323).

Another difficulty in comparing degrees and institutions is the lack of methods that measure student learning and graduate outcomes. Although tools such as student evaluations and employer perceptions and surveys can measure student learning, there is currently no standard way to measure student learning. There must be more research done in this area in order to effectively evaluate graduate degree programs and measure their performances against each other (Kretovics, 199: 126, 134).

There are some who feel the MBA was indeed a viable advanced degree for managers in the past but complain that it has become outdated in today's ever-changing environment that relies heavily on computer technology and communications. Needham posed a very poignant question when she asked: "Is the MBA the best vehicle for success as a communications manager, or would you be better off with a master of science degree that combines MBA courses with technical courses? There's a lot to be said for taking the latter route" (1991: 45). Needham also expressed her view of MBA shortcomings when she claimed: "The MBA has certainly become an accepted path into management and is likely to remain so. But MBA programs also reflect the current

preoccupations of business overall. And these preoccupations, alas, are not very technical" (1991: 45).

The other side of the debate claims that MBAs provide vital business skills to engineers. In his article entitled "The Value of an MBA for Engineers," Slack discussed the merits of an MBA: "Business schools have a long tradition of providing MBAs for the engineering industry and up to one-quarter of their students come from this field. In common with people from other professional backgrounds, many engineers find that technical knowledge alone with not help them rise up the corporate ladder" (1999: 231).

Researchers such as White believe this heavy reliance on advanced degrees can be very dangerous if the qualities of the degrees are not validated. For example, some institutions offer degrees in Industrial Technology. On face value, such a degree sounds very technical, but in reality, there is little engineering involved. White also commented that a degree in itself may not be enough to make an effective manager: "On the other hand there are many tasks at the development end of the R&D spectrum where research training or even a degree is less important than an aptitude for combining scientific knowledge with engineering-type thinking" (White, 1975: 225).

In an effort to quantify the differences between graduate degrees and their impact on upper management, Schrader studied various Chief Executive Officers (CEOs) of top U.S. companies, both technical and nontechnical. Harhoff commented on Schrader's findings: "For firms with prospecting behavior, a combination of technical and economic/managerial training is positively associated with success, while exclusive economic or management training is detrimental" (Brockhoff, 1999: 139). Harhoff discussed this finding and Schrader's final conclusions in relation to MBAs:

> Despite the complexities of these patterns, one surprising result is clear: exclusively economic or managerial training per se is detrimental to performance, both for defender and prospector firms. This is worrisome news for anybody concerned about the societal contribution of business administration as a discipline. (Brockhoff, 1999: 139)

This finding lends credence to the importance of technical education in managerial training.

Graduate Degrees of CEOs in Top Government Contract Companies

In August 1999, Government Executive magazine listed the top 10 government contractors according to the amount of contract awards they received from the U.S. government. Information revealed by an Internet search of these Top 10 government contractors is listed in Table 1, and it displays the listing of the CEOs, the companies they are in charge of, the graduate degree they earned, and institution they earned it from.

Table 1. Listing of Graduate Degrees for CEOs of Top Government Contracting Companies

CEO	Company	Master's Degree	Institution
Daniel Burnham	Raytheon	MBA	University of New Hampshire
Lewis Campbell	Textron	MBA	Harvard International (Switzerland)
Nicholas Chabraja	General Dynamics	Law	Northwestern
Vance Coffman	Lockheed Martin	Aeronautics	Stanford
Phil Condit	Boeing	Aeronautical Eng. M.S. Management	Princeton M.I.T.
William Fricks	Newport News Shipbuilding	MBA	William and Mary
Karl Krapek	United Technologies Corp.	M.S. Industrial Admin.	Purdue
Kent Kresa	Northrop Grumman	Aeronautics MBA	M.I.T. New York University
Ray Sugar	Litton Industries	Electrical Engineering	California University
John Welch	General Electric	Chemical Engineering	University of Illinois

Source: Government Executive, Individual Company Web sites

Notable in the Table 1 are the CEOs of both remaining military aircraft producers in the U.S.: Boeing and Lockheed Martin. Also represented are both major engine

manufacturers (General Electric and United Technologies which owns Pratt & Whitney) and other top prime government contractors such as Litton, General Dynamics, and Raytheon. Table 1 shows that there is a mix of nontechnical and technical degrees among these CEOs. Kresa of Northrop Grumman is the only one who holds both a nontechnical (MBA from New York University) and a technical degree (MS degree in Aeronautics from M.I.T). In the Air Force, the equivalent of CEOs are the general officers who are responsible for policy decisions and the overall direction of the Air Force.

Role of Graduate Education in the USAF

Fearing that the U.S. had lost its edge on technology in the post-World War II environment, General Hoyt S. Vandenberg, Chief of Staff of the USAF, commissioned a study in April 1949 to address the issue of overall research and development in the USAF. This study, known as the Ridenour Report, was headed by a committee of prominent scientists and business leaders and formally studied the R&D processes and organization of the USAF. In September 1949, Dr. Theodore von Kármán submitted the formal report with conclusions and eight major recommendations. The fifth major recommendation dealt with the subject of technical training of its officers: "The Air Force presently has far too few officers with technical qualifications, despite the highly technical nature of the Air Force mission" (1949: Letter 3).

The Ridenour Report went into more specific detail concerning the technical qualifications of its officers and discussed the major complaints within the Air Force:

1. The lack of sufficient emphasis on technical qualifications in considering reserve officers for integration.
2. The absence of constructive effort to retain in the Air Force those officers who received postgraduate training at government expense during and shortly after the past war.
3. The general belief among officers that career advancement cannot be secured by excellence in technical work.
4. Ill-advised rotation and assignment policies which dissipate the skills of the few technically qualified officers possessed by the Air Force.
5. The lack of a career guidance plan for technical officers.
6. Inadequate research and development personnel allotments (1949: VII-1).

In order to combat the above shortcomings, the Ridenour Report discussed several recommendations, one of which involved graduate and postgraduate education of Air Force officers. It recommended that the Air Force continue postgraduate training and that this training receive support from the highest echelons of Air Force leadership (Ridenour, 1949: VIII-8).

The committee also specifically discussed the role of the Air Force Institute of Technology (AFIT). It recommended that AFIT be turned into a high-quality graduate school of engineering. It claimed that this benefit of technically trained men would far outweigh the costs and that the tangible benefits would be incalculable (Ridenour, 1949: X-4).

In addition to the Air Force Institute of Technology, officers were also sent to many civilian institutions for graduate and postgraduate education. General Samuel

Phillips, former commander of Air Force Systems Command, commented on the education he received after returning from World War II and the benefits that he and many other officers received: "The education program and opportunities that were created in the 1940s and carried on for many years were really the foundation on which the Air Force built and expanded its ability to plan and manage its research, development, procurement, production, and acquisition programs" (Neufeld, 1993: 43).

This emphasis on technical education continued well into the 1960s. A listing of the advanced degree requirements in 1963 showed that 43 percent of all graduate degrees required were in the science and engineering category (7,020 out of 16,380 total degrees). Under this category fell the subcategories of physical/biology sciences, engineering, and mathematics. This number rose to 47 percent in 1968 (5,167 out of 10,834 total degrees) and 52 percent in 1969 (6,069 out of 11,709 total degrees) (Thorne, 1970: 13,14).

All that began to change in the 1970's. In his AFIT thesis, Silliman claimed: "Recently there has been an increase in the percentage of qualified officers refusing the opportunity for master's degree education under the AFIT programs and particularly those programs of the AFIT residence schools" (1972: 1). He claimed these declination rates were lowering incoming student quality and went on to specify which areas were not achieving their quotas: "...An increasing percentage of the most qualified candidates are not entering AFIT's master's degree programs. This problem seems to be most significant in the engineering disciplines at the Residence School of Engineering" (Silliman, 1972: 5).

This declining trend in engineering degrees was also seen in the civilian sector and may have influenced those officers who declined education in the engineering fields.

In 1971, Frey claimed, "Over the last year, there has been a shift in national priorities away from the development of defense systems to social and environmental concerns" (19). Frey also went on to claim that the Japanese and Soviets were generating engineers four times faster than the United States (19).

Need for Officers with Technical Educations

Education has been stressed throughout the Air Force's history. According to Boyne: "Education has been the saving grace of the United States Air Force, in terms of capability and its immutable corollary, the retention of qualified personnel" (1997: 202). The US Air Force of 2000 is the most technologically advanced in history. Technologies such as stealth, composite materials, information technologies, and computer advancements require officers who are technically competent. A 2000 report by the Air Force Association (AFA) claimed: "Of equally critical importance is the need to educate and nurture a skilled cadre of Air Force officers in the R&D and S&T community. The evolution of Air Force leaders… is the crucial factor in rebuilding and maintaining Air Force R&D" (3).

In addition to officers skilled in R&D, the AFA report cited the need for competent technical officers in the acquisition field: "The slowly diminishing number of highly qualified acquisition officers is of great concern" (2000: 3). Without technically competent acquisition officers, it will be difficult to acquire the advanced weapons and information systems required in the future. If acquisition officers are not familiar with the technologies they are purchasing, incorrect contract requirements and specifications become more likely. This could not only delay the acquisition of the technology but also

cost the Air Force a great deal of money and a possible technological advantage over its enemies.

In addition to working with advanced technologies, officers are also responsible for leading and managing a very technically competent enlisted force. According to Air Force Personnel Center statistics, today's Air Force enlisted force is the most educated in history (Air Force Personnel Center, 2000: n. pag.). It is critical that the Air Force officer corps maintain technical competence in order to make sound technical decisions and effectively manage its technically competent enlisted force.

Definition of Technical Graduate Degrees

Although the Air Force does not formally classify various degrees as technical or nontechnical, AFI 36-2205 Applying for Flying and Astronaut Training Programs. It gives some insight into what the Air Force considers technical degrees and those degrees it does not consider technical degrees. AFI 36-2205 lists the qualifying degree fields for the astronaut nomination program and divides them up into 5 major categories: Engineering, Biological Science, Physical Science, Mathematics, and Computer Science. A listing of all qualifying degrees is found in Table 2. For the purpose of this analysis, this study will consider all degrees in this list as technical graduate degrees. In addition, it will also consider the degrees in Table 3 as technical due to their heavy involvement in quantitative engineering or computer engineering subjects.

Table 2. List of Technical Degrees Defined by AFI 36-2205

Engineering	Biological Science	Physical Science
Aeronautical Engineering	Anatomy	Analytical Chemistry
Aerospace Engineering	Bacteriology	Astronomy
Agricultural Engineering	Biochemistry	Astrophysics
Architectural Engineering	Biology	Atmospheric Science
Astronautical Engineering	Biophysics	General Chemistry
Bioengineering	Biostatistics	Earth Science, General
Biomedical Engineering	Botany	Geochemistry
Ceramic Engineering	Cell Biology	Geology
Chemical Engineering	Ecology	Geophysics
Civil Engineering	Embryology	Inorganic Chemistry
Construction Engineering	Entomology	Metallurgy
Electrical Engineering	Genetics	Meteorology
Electronics Engineering	Histology	Molecular Physics
General Engineering	Marine Biology	Nuclear Physics
Engineering Mechanics	Microbiology	Oceanography
Engineering Physics	Molecular Biology	Organic Chemistry
Environmental Engineering	Neurosciences	Pharmaceutical Chemistry
Geological Engineering	Scientific Nutrition	Physical Chemistry
Geophysical Engineering	Pathology	Physical Science
Industrial Engineering	Pharmacology	
Marine Engineering	Physiology	**Mathematics**
Materials Engineering	Plant Pathology	Applied Mathematics
Mechanical Engineering	Plant Pharmacology	General Mathematics
Metallurgical Engineering	Plant Physiology	Statistics
Mineral Engineering	Radiobiology	
Mining Engineering	Toxicology	**Computer Science**
Nuclear Engineering	Wildlife Biology	(Scientific, Engineering, or
Ocean Engineering	Zoology	Mathematical Applications)
Transportation Engineering		

Table 3. Technical Degrees Defined by This Study and Not Found in AFI 36-2205

Analysis and Forecasting	Space Operations
Operations Research	Systems Engineering
R&D Management	

Nontechnical Graduate Degrees

For the purpose of this study, nontechnical graduate degrees will be defined as those degrees that do not involve science and engineering and are heavily involved in management. The list of nontechnical degrees as defined by this study is found in Table 4.

Table 4. Listing of Nontechnical Graduate Degrees

Acquisition/Logistics Management			Industrial Technology	*
Aeroscience Technology/Studies			Information/Resource Management	
Archaeology	*		Language (Public Relations)	
Area Studies			Military Arts and Science	
Aviation Management	*		Procurement Management	
Business Administration			Psychology	*
Cost Analysis			Public Administration	
Criminology/Forensics			Social Sciences	
Economics			Sociology	
Education			Space Studies	
Engineering Technology/Management	*		Strategic Intelligence	
Fine and Applied Arts			Systems Management	
Geography	*		Systems Technology, C3I	
General/Liberal Studies			Space Studies	
History			Telecommunications	
Human Resource Management				

Those degrees highlighted in Table 3 by an asterisk (*) are those degrees AFI 36-2205 defines as nontechnical despite being related to engineering and the sciences. All of the above degree definitions (nontechnical and technical) will be used throughout the rest of this study.

Current Air Force Graduate Education System

The management of graduate education in DoD is governed by DoD Directive 1322.10, Policy on Graduate Education for Military Officers. This directive's stated

purpose is to "raise the levels of individual military officer professionalism and technical competence" (DODD 1322.10, 1990: 1). In addition, much of this directive addresses the fully funded and partially funded graduate education for military officers. It gives the responsibility of providing and managing graduate education to each of the services. It also encourages officers who do not qualify for fully funded education to pursue a graduate degree "for its considerable personal and professional value to those officers" (DODD 1322.10, 1990: 2). This directive also mandates that each branch of the military manage graduate programs to include managing the officers once they receive degrees and determining requirements (DODD 1322.10, 1990: 3).

The current USAF graduate education process is owned by Headquarters, United States Air Force. According to Air Force Policy Directive 36-23, Military Education, "HQ US Air Force is responsible for policy oversight and advocacy of the Air Force's military education programs and for interface with the Office of the Secretary of Defense staff concerning development of DoD policy and legislative initiatives" (AFPD 36-23, 1993: 2). Additionally, "the Air Force provides advanced academic education to prepare officers to perform the duties of a specifically designated position (or to meet the needs of a particular career field)" (AFPD 36-32, 1993: 1).

One major component of the military graduate education process is the Advanced Academic Degree requirement (AAD). AAD positions are specially coded positions within the Air Force that require officers to have specific advanced degrees. AAD-coded positions are normally found at senior staff levels, including major command headquarters (Air Force Material Command, Air Combat Command, etc.) and the Air

Staff, located at the Pentagon. Air Force Instruction 38-201, Determining Manpower Requirements, sets forth the process in determining the AAD positions:

> 8.1.1. HQ USAF functional managers or academic specialty monitors (ASM) develop criteria for assessing AAD requirements for their career field and will provide this criteria to MAJCOM, FOA, DRU, and joint activity functional managers and DP for use in the verification process. Annually, ASMs attend the Air Force Requirements Boards (AFERBs) which verify graduate education requirements. (AFI 38-201, 1999: 30)

Although AAD billets are extremely important, they are but a small percentage of the available jobs in the Air Force. Aside from the aforementioned management of AAD degree requirements and positions, there is little or no management of the rest of the officer corps concerning graduate education. In order to fully understand an analysis of Air Force officers, their career fields, and their graduate education, it is important to understand Air Force Specialty Codes (AFSC). A detailed explanation of AFSCs and their meaning is discussed in the following section.

Air Force Specialty Codes

AFSCs are alphanumeric designations used by the Air Force to specify various careers and job specialties and are governed by AFI 36-2105, Officer Classification. The basic AFSC consists of a four-symbol code. The first symbol is a number and this designates the overall Air Force Specialty (AFS) or career area. The AFS is a basic grouping of positions that require similar skills and qualifications. There are 9 major Air Force Specialties and their codes are listed in Table 5. For example, all officers in the operations specialty will have AFSCs that begin with 1 (1XXX).

Table 5. List of Air Force Specialties

Air Force Specialty	Code
Operations	1
Logistics	2
Support	3
Medical	4
Professional	5
Acquisition	6
Special Investigations	7
Special Identifier	8
Reporting Identifier	9

The second symbol is called the AFS utilization field and is also always a number. This number specifies a utilization field within a specific AFS. For example, within the Operations AFS, a pilot will be designated by 11XX while a navigator will be designated by 12XX. All specific AFSCs and their meanings are found in AFVA 36-211, Officer Classification Chart.

The third symbol identifies specific specialties within utilization fields and is a letter. For example, this letter would be used to differentiate the various types of pilots. A fighter pilot would be designated as 11FX while an airlift pilot would be designated as 11AX.

The fourth symbol is a number and identifies the skill level of the officer. The skill level can only be an integer between "1" and "4". A "1" designates an entry-level officer (XXX1), a "2" designates an intermediate officer (XXX2), a "3" designates a qualified officer (XXX3), and a "4" designates a staff officer (XXX4). Each career field has its own guidelines and requirements to advance to the next qualification level.

The basic AFSC is a four-symbol code, but AFSCs can also have prefixes and suffixes and these are also outlined in AFVA 36-211. Prefixes are letters and identify significant skills not restricted to a single AFSC. For example, a "C" prefix designates a commander. Suffixes are specialty shredouts and identify specific equipment, functions, or specializations within an AFS. For example, within the scientist career field (61SX), there are 5 suffixes. An "A" designates an Analytical Scientist, a "B" designates a behavioral scientist, a "C" designates a chemist, a "D" designates a physicist, and an "E" designates a mathematician.

Role of Scientists and Engineers in Air Force R&D

The roles, job descriptions, and the duties and responsibilities of Air Force scientists and engineers are defined by AFMAN 36-2105, Officer Classification. Scientists are responsible for managing programs, projects, and activities that pertain to research. The primary duties and responsibilities for scientists are as follows:

1. Conducts and manages research.
2. Develops new concepts, methods, and techniques to solve scientific problems.
3. Recommends research and development projects, and acceptance or non-acceptance of research products.
4. Manages scientific programs, projects, and activities. Performs as staff officer and manager in positions requiring technical specialization (AFMAN 36-2105, 2000: Attachment 40).

The duties and responsibilities of developmental engineers are as follows:

1. Accomplishes systems engineering processes and sub-processes.

2. Coordinates engineering and technical management activities
3. Formulates engineering and technical management policies and procedures
4. Plans, organizes, and directs engineering and technical management operations (AFMAN 36-2105, 2000: Attachment 42).

Upon commissioning, most scientists and engineers work in their selected fields, gaining hands-on R&D experience and learning the Air Force R&D process. The initial emphasis is on gaining technical excellence. As the officer progresses, the emphasis shifts from a pure engineering or science to one of project management. Project management consists of ensuring a program is on schedule, meets specific performance and contract requirements, and stays within budget. It is imperative that those project managers dealing with technical subjects understand project management, the technical processes, and their managerial responsibilities.

Overall Purpose of Study

The main thrust of this thesis is to determine if in the last 10 years there indeed has been a shift of graduate degrees away from the more technically oriented degrees such as the physical sciences and engineering fields and more into less technically oriented degrees such as business administration and personnel management. Although many senior officers do indeed have nontechnical degrees and they are very good leaders and managers, the Air Force must also have senior officers who completely understand the technical processes and can therefore make better decisions concerning technology and research and development.

In order to fully explore the subject, four proposals will be set forth and tested: (1). From 1990 to 2000, there has been an overall diminution of USAF line officers that have technical graduate degrees. (2). In the past 10 years, there has been a decrement in senior officers (colonel through general) that have technical graduate degrees. (3). In the past 10 years, there has been a decrease of technical degree graduates in career fields where an advanced degree is critical to the performance of their job (scientists (61SX), developmental engineers (62EX), and acquisition officers (63AX)). (4). Since 1990, there has been a decrease of graduate technical degrees in the following career fields: 11XX (pilots), 32EX (civil engineers), and 33SX (communications and information officers).

Chapter Summary

This chapter discussed the history of technology in the United States Air Force from post-World War II up until the present times and highlighted significant contributions by Air Force officers with technical degrees. It then looked overall at the subject of research and development management. An analysis of the role of graduate education in today's civilian companies followed with a discussion of the current topics of debate. An analysis of the role of graduate education in the USAF followed a discussion on the graduate degrees of many of the CEOs of the largest government contracting companies. Next, the current DoD and USAF graduate education management systems were examined. It then discussed the need for Air Force officers who are technically competent and educated. A detailed explanation of Air Force Specialty Codes was followed by a discussion of the position and responsibilities of

scientists and engineers in the Air Force R&D process. Finally, four specific proposals to be addressed in Chapter III were proposed.

III. Methodology

Chapter Overview

This chapter will discuss the overall methodology used in this study. It first will discuss the data and possible discrepancies with the data. It will then review the original research questions proposed in Chapter I. After that, it will discuss the methodology and statistical methods used to address these four proposals. The first statistical method will be observed data tables that list the graduate degrees and the number of officers in each respective category (overall, senior leadership, etc.). These tables will then be used to calculate the percentages of officers in specific AFSCs receiving specific degrees. The second statistical method will be the chi-square test to determine if there is a statistical difference in the percentages of technical and nontechnical degrees between the years of 1990 and 2000. Finally, it will discuss how the statistics will be used in the context of the four proposals set forth at the end of Chapter II.

Data

The data analyzed originated from the Air Force Personnel Center (AFPC) personnel database located at Randolph Air Force Base, San Antonio, Texas. This database keeps current and past records of almost all Air Force officers. Because of this, the data consists of nearly the entire population of Air Force officers and confidence intervals are not necessary. This also allows this study to be generalized to the Air Force as a whole. The database contains countless attributes of each individual officer but only

a select few will be analyzed for this study. These main attributes include: rank, institution of highest/second highest degree, highest academic degree, second academic degree, primary AFSC, and secondary AFSC.

Since all line officers have undergraduate degrees, the default for the highest academic degree is the officer's undergraduate degree. This is also reflected in the officer's academic institution. If an officer achieves a master's degree, this degree then becomes the highest academic degree and the undergraduate degree then becomes the second-highest academic degree. This is also reflected in the respective institutions. If an officer obtains a PhD, this degree and institution then become the highest, the master's degree and institution become the second, and the undergraduate degree and any other secondary masters degrees and institutions are dropped off. It is unclear if an officer has multiple master's degrees and earns a PhD, which master's degree is dropped from the database, but the amount of time it would take an officer to achieve so many degrees minimizes the number of officers this would affect.

This creates some problems with the data when an officer has a PhD, but this determination is fairly straightforward and can be inferred by looking at the second institution and degree. For example, the service academies only offer undergraduate training and the Air Force Institute of Technology only offers masters and PhD programs. Therefore, if an officer has the U.S. Air Force Academy listed as secondary, the highest degree is the master's degree.

Possible Data Discrepancies

Due to the nature of the data available to this author, there is some discrepancy in matching the degree to the primary AFSC and secondary AFSC. The data acquired does not specify which AFSC is more current or which AFSC the officer has spent the majority of time in or is currently operating in. Nor does it specify toward which AFSC the advanced degree was earned. For example, if an officer has a primary duty AFSC of 62EX (developmental engineer) and a secondary AFSC of 21XX (logistician) and the officer has a degree in logistics management, one can infer that the officer is currently working in the logistics career field, but this is not necessarily the case. The officer may have originally been in the 21XX career field, achieved a degree in logistics management and then later cross-trained into the developmental engineering career field. Although these instances are the exception, not the rule, they nonetheless have an impact on the subject of this analysis. For the purpose of this study, the percentage of discrepancies for each career field will be presented in the results section (Chapter IV).

Another limitation of the data acquired by this author is that there are no dates associated with the degrees. If an officer has multiple graduate degrees, it is very difficult if not impossible to determine which degree is the more recent. In addition, it can be difficult to determine if the secondary degree is an undergraduate degree or an additional masters degree.

Original Research Questions

The overarching question concerning this study is: Has there been a decrease in technical education of officers in the Air Force? An increase in the percentage of officers

achieving technical degrees in technically oriented career fields or career fields that are heavily involved in Air Force leadership would lend credence to the argument that the Air Force is maintaining and increasing its emphasis on technical excellence. A decrease in the percentage of officers achieving technical degrees in technically oriented career fields or career fields that are heavily involved in Air Force leadership would lend credence to the argument that the Air Force is losing some technical excellence and decreasing the emphasis on technology and research and development. The original research question cannot be answered using only one method so it will be answered with the four proposals discussed at the end of Chapter II.

Percentage of Officers With Specific Degrees

The percentage of officers with specific graduate degrees in each of the two respective years (1990 and 2000) will be calculated by dividing the number of officers in a specific career field with a specific graduate degree by the total number of officers in that career field. For example, in 1990 if there were 100 officers in the 62E3A career field (developmental engineering) and there were 75 developmental engineers that had degrees in aeronautical engineering, the percentage of developmental engineers that had a degree in aeronautical engineering is calculated by dividing 75 by 100. This means that in 1990, 75 percent of developmental engineers had a graduate degree in aeronautical engineering. Although AFSCs have changed over the last 10 years, this has only affected the Communications and Information (33SX) career field. This will be discussed in the discussion of 33SX results section in Chapter IV.

The specific types of degrees officers achieve have been divided into two categories: technical and nontechnical (as defined in Chapter II). The individual percentages of the specific degrees in both categories will be added together to determine the overall technical and nontechnical percentages. These overall percentages will be compared between the years 1990 and 2000 determine if there is a difference. For example, reference the following hypothetical percentages for all USAF officers:

	1990	2000
% of officers with degrees in physics	.05	.04
% of officers with other technical degrees	.20	.16
% of officers with technical degrees	.25	.20

In the above example, the percentage of physics degrees in 1990 (.05) will be added to the other technical degrees. This percentage is .25. The same numbers will be calculated for the year 2000 and then the overall percentages will be compared. In the above example, there has been an overall decrease in technical degrees from 25 percent to 20 percent. If this percentage change were found to be statistically significant this would lend credence to the argument that there has been an overall loss of technical graduate education in the Air Force.

Chi-Square Test

In order to determine if the difference in percentages between 1990 and 2000 is significant, a chi-square (χ^2) test will be used. The hypothesis being tested is whether or not the two groups (1990 and 2000) differ with respect to technical graduate degrees.

Specifically, it will determine whether the two groups differ in the proportions with which they fall into the two classifications (technical and non-technical). To test this hypothesis, the number of cases from each group that fall in the two categories are counted and then placed in a 2 x 2 table. A sample 2 x 2 table is found in Table 6.

Table 6. Sample 2 x 2 Chi-Square Table

	Group		
Variable	**1990**	**2000**	**Combined**
# of officers with technical degrees	**A**	**B**	**A+B**
# of officers with nontechnical degrees	**C**	**D**	**C+D**
Total # of officers	**A+C**	**B+D**	**N**

For the purposes of this study, the null hypothesis (H_o) is there is no statistical difference between the percentage of technical degrees earned in 1990 and in 2000. Conversely, the alternate hypothesis (H_a) is there is a statistical difference between the percentage of technical degrees earned in 1990 and in 2000. The percentage of technical degrees in 1990 can be written as (p_{1990}) and the percentage of technical degrees in 2000 can be written as (p_{2000}). The above null and alternate hypotheses are as follows:

$$H_o\text{: } p_{1990} = p_{2000}$$

$$H_1\text{: } p_{1990} \neq p_{2000}$$

For the purpose of this study, the significance level (α) will be .05. The degrees of freedom is calculated using the formula (r-1)X(c-1) where (r) equals the number of rows and (c) equals the number of columns. In the case of the 2 x 2 table used in this study, the number of rows and columns equals 2 and the degrees of freedom is calculated by (2-1)X(2-1) = 1.

Using the same notation as in Table 6, the following equation will be used to determine the specific chi-square test value:

$$\chi^2 = \frac{N(\langle AD - BC \rangle - N/2)^2}{(A+B)(C+D)(A+C)(B+D)} \qquad \text{df} = 1$$

Once the test statistic is calculated using the above equation, it must be compared to the critical values of χ^2 based on the aforementioned significance level ($\alpha = .05$) using a standard critical value table found in most statistics books. Using an alpha value of .05, and 1 degree of freedom yields a critical value of 3.84146. If the calculated test value exceeds the critical value, then the null hypothesis of no significant difference is rejected in favor of the alternate hypothesis. This can also be written as follows:

If calculated $\chi^2 \geq$ critical value (3.84146), reject null hypothesis

The specific chi square test for significance will be examined in detail for the overall Air Force test and each specific career field in Chapter IV.

Proposal Testing

In Chapter II, four proposals were discussed. The first proposal is: From 1990 to 2000, there has been an overall diminution of USAF line officers (second lieutenant Through lieutenant colonel) that have technical graduate degrees. In order to test this

proposal, all technical and nontechnical graduate degrees (as defined in Chapter II) will be counted for both 1990 and 2000 and then divided by the total number of line officers in each respective year. This will provide the overall percentage of officers with technical and nontechnical degrees. These two percentages will be compared using the aforementioned chi-square test to see if there is a statistical difference.

The second proposal is: In the past 10 years, there has been a decrement in senior line officers (colonel through general) that have technical graduate degrees. As in the earlier example, all senior line officers with graduate degrees will be counted and then divided by the total number of senior line officers to show the percentage of graduate degrees in each category (technical and nontechnical) in each year. These numbers will again be used in a chi-square test to determine if a statistical difference exists.

The third proposal is: In the past 10 years, there has been a decrease of technical degree graduates in career fields where an advanced degree is critical to the performance of their job (scientists (61SX), developmental engineers (62EX), and acquisition management officers (63AX)). This will be determined using the same percentage calculations as indicated by the two previous proposals. The-chi square test will again be used to determine if a statistical difference exists within each career field.

The fourth proposal is: Since 1990, there has been a decrease of technical graduate education in the following career fields: 11XX (pilots), 32EX (civil engineers), and 33SX (communications and information officers). Again, the percentages of officers within each of these career fields with technical degrees will be calculated as described above for both 1990 and 2000 and then compared. The-chi square test will again be used to determine if a statistical difference exists within each career field.

Chapter Summary

This chapter discussed the methodology and data used in this study. After analyzing possible data discrepancies it revisited the research questions originally stated in Chapter I. It then discussed how the percentages of officers with specific graduate degrees would be calculated. Then it specifically discussed the chi-square test and how it will be used in the context of this study. Finally, it examined the four detailed proposals set forth in Chapter II and how each one will be tested.

IV. Results

Chapter Overview

This chapter specifically discusses the results of this study found using the methodology presented in Chapter III. It will examine the four proposals set forth in Chapter II. First it will examine all officers in the Air Force. Then it will discuss senior leadership in the Air Force. After that, it will address the third proposal of a decrease in technical degrees in the following career fields: scientist (61SX), developmental engineer (62EX), and acquisition manager (63AX). Finally, it will specifically discuss the graduate degree comparisons in the following career fields: pilots (11XX), civil engineers (32EX), and communications and information officers (33SX). As mentioned in Chapter III, each specific section will discuss the number of AFSC discrepancies where the duty AFSC and the secondary AFSC are two completely different career fields.

Comparison of Line Officers Air Force Wide

The observed frequency table of overall graduate degrees in the Air Force in 1990 and 2000 is found in Appendix A. The specific degree and overall percentages are found in Appendix B. The number of line officers Air Force-wide has decreased from 41,173 in 1990 to 27,743 in 2000 for an overall decrease of 32.6 percent. This decrease is mainly due to cutbacks following Desert Storm and has affected all categories addressed in this study. The number of nontechnical degrees decreased from 33,423 in 1990 (81.2 percent of all Air Force degrees) to 22,449 in 2000 (80.9 percent of all Air Force degrees) for an overall decrease of .3 points. The number of technical degrees decreased from

7,750 in 1990 (18.8 percent of all Air Force degrees) to 5,294 (19.1 percent of all Air Force degrees) for an overall increase of .3 points.

The chi-square test statistic value was 1.1383774 (see Appendix Q). Based on the selected alpha value ($\alpha = .05$) the test statistic does not exceed the critical value of 3.84146. This indicates that the overall percentage change in technical and nontechnical graduate degrees is not a significant change. Therefore, this study concludes that there has not been an overall diminution of USAF line officers with technical graduate degrees from 1990 to 2000. Instead, there has been a slight, but not statistically significant, increase in the percentage of officers with technical degrees.

Although there has not been a significant change between the percentages of nontechnical and technical degrees, there has been a shift among the nontechnical degrees. The largest increase was the aeroscience technology/aerospace studies degree with an increase of 10.1 points. This is mainly due to the increase in the number of pilots that obtained this degree in 2000 (see Appendix E). The two nontechnical degrees that decreased the most were business administration, with an overall decrease of 4.3 points, and systems management, with an overall decrease of 3.7 points.

Graduate Degree Comparison of Senior Line Officers

The observed frequency table of senior leadership graduate degrees in the Air Force in 1990 and 2000 is found in Appendix C. The specific degree and overall percentages are found in Appendix D. The total number of senior line officers with graduate degrees decreased from 4,304 to 3,285 for an overall decrease of 23.7 percent. The number of nontechnical degrees decreased from 3,722 in 1990 (86.5 percent of all

senior line officer degrees) to 2,804 in 2000 (85.4 percent of all senior line officer degrees), for a decrease of 1.1 points. The number of technical degrees decreased from 582 in 1990 (13.5 percent of all senior line officer degrees) to 481 in 2000 (14.6 percent of all senior line officer degrees) for an increase of 1.1 points.

The chi-square test value of 1.848366 (see Appendix Q) does not exceed the test value of 3.84146. This means that the 1.1 point change is not statistically different. Therefore, this study concludes that there has not been a decrement in senior leadership line officers (colonel through general) with technical graduate degrees. There has been also been a slight, but not statistically significant, increase in the percentage of senior line officers with technical graduate degrees.

Scientists (61SX) Graduate Degree Comparison

The observed frequency table for scientists is found in Appendix K and the percentages are found in Appendix L. The number of scientists with graduate degrees decreased from 1,079 to 638 for an overall decrease of 40.9 percent. The number of nontechnical graduate degrees decreased from 239 in 1990 (22.2 percent of all scientist degrees) to 116 in 2000 (18.2 percent of all scientist degrees) for an overall decrease of 4 points. The number of technical graduate degrees decreased from 840 in 1990 (78 percent of all scientist degrees) to 522 to 2000 (82 percent of all scientist degrees) for an increase of 4 points.

The calculated chi-square value of 3.611486 (see Appendix Q) does not exceed the critical value of 3.84146. Therefore, this study concludes that there has not been a decrease in the percentage of scientists with technical graduate degrees. There has been a

slight, but not statistically significant, increase of 4.0 points of technical degrees. In 1990, the number of data discrepancies was 222 out of 1,079 (20.6 percent). In 2000, this same measure was 94 out of 638 (14.7 percent).

Developmental Engineers (62EX) Graduate Degree Comparison

The observed frequency table for developmental engineers is found in Appendix M and the percentages for are found in Appendix N. The overall number of developmental engineers with graduate degrees decreased from 3,316 to 1,502 for an overall decrease of 54.7 percent. The number of nontechnical graduate degrees decreased from 885 in 1990 (26.7 percent of overall developmental engineer degrees) to 378 in 2000 (25.2 percent of all developmental engineer degrees) for an all decrease of 1.5 points. The number of technical graduate degrees decreased from 2,431 in 1990 (73.3 percent of all developmental engineer degrees) to 1,124 in 2000 (74.8 percent of all developmental engineer degrees) for an overall increase of 1.5 points.

The calculated chi-square test value of 1.161142 (see Appendix Q) does not exceed the critical chi square value of 3.84146. Therefore, this study concludes that there has been no decrease in the percentage of scientists with technical graduate degrees. There has been a slight but insignificant increase in the percentage of scientists with technical graduate degrees. In 1990 the number of data discrepancies was 329 out of 3,316 (9.9 percent) and in 2000 the number was 154 out of 1,502 (10.3 percent).

Acquisition Managers (63AX) Graduate Degree Comparison

The observed frequency table for acquisition managers is found in Appendix O and the percentages are found in Appendix P. The total number of acquisition managers with graduate degrees decreased from 1,605 to 1,532 for an overall decrease of 4.5 percent. The number of nontechnical degrees decreased from 1,191 in 1990 (74.2 percent of all acquisition degrees) to 1,041 in 2000 (68 percent of all acquisition degrees) for a decrease of 6.2 points. The number of technical degrees increased from 414 in 1990 (25.8 percent of all acquisition degrees) to 491 in 2000 (32.0 percent of all acquisition degrees) for an increase of 6.2 points.

The calculated chi-square value of 14.63818 (See Appendix Q) exceeds the critical value of 3.84146. This indicates that the 6.2 point increase of technical degrees is a significant shift. Most notably among the list of the technical degrees that increased were aeronautical/astronautical Engineering (2.2 points), general engineering (4.1 points), and mechanical engineering (1.2 points). Among the nontechnical degrees that decreased were business administration (3.2 points) and systems management/analysis (8.4 points). The nontechnical aeroscience technology/studies degree increased by 3.6 points. In 1990, the number of data discrepancies was 372 out of 1,605 (23.2 percent) and in 2000 this number was 366 out of 1,532 (23.9 percent).

Pilots (11XX) Graduate Degree Comparison

The observed frequency table for pilots is found in Appendix E and the percentages are found in Appendix F. The number of pilots with graduate degrees decreased from 7,929 to 6,165 for an overall decrease of 22.2 percent. The number of

nontechnical degrees decreased from 7,080 in 1990 (89.3 percent of all pilot degrees) to 5,353 in 2000 (86.8 percent of all pilot degrees) for an overall decrease of 2.5 percent. The number of technical degrees decreased slightly from 849 in 1990 (10.7 percent of all pilot degrees) to 812 in 2000 (13.2 percent of all pilot degrees) for an overall increase of 2.5 points.

The calculated chi-square value of 20.0162 (see Appendix Q) exceeds the critical value of 3.84146 so the 2.5 point increase in technical degrees is statistically significant. Of the technical degrees, aeronautical/astronautical engineering increased the most (1.37 percent). In addition to decreasing overall, the nontechnical degrees saw a large internal shift. Aeroscience technology/studies increased by 23 points, while business administration decreased by 4.4 points, psychology decreased by 3.1 points, public administration decreased by 2.8 points, and systems management/analysis fell by 5.4 points. The number of pilot discrepancies in 1990 was 382 out of 7,929 (4.8 percent) and in 2000 the same measure rose to 467 out of 6,165 (7.8 percent)

Civil Engineers (32EX) Graduate Degree Comparison

The observed frequency table for civil engineers is found in Appendix M and the percentages are found in Appendix N. The number of total civil engineers with graduate degrees decreased from 1,084 to 799 for an overall decrease of 26.3 percent. The number of nontechnical degrees decreased from 663 in 1990 (61.2 percent of all civil engineer degrees) to 416 in 2000 (52.1 percent of all civil engineer degrees) for an overall decrease of 9.1 points. The number of technical degrees decreased from 421 in 1990 (38.8 percent

of all civil engineer degrees) to 383 in 2000 (47.9 percent of all civil engineer degrees) for an overall increase of 9.1 points.

The calculated chi-square value of 15.18905 (See Appendix Q) exceeds the critical value of 3.84146 so the 9.1 point increase is statistically significant. Importantly, the number of civil engineering graduate degrees increased from 216 to 300 for an increase of 17.6 points. Again, the largest decrease in nontechnical degrees was business administration with a decrease of 2.3 points. The number of civil engineer data discrepancies was 54 out of 1,084 in 1990 (5.0 percent) and in 2000 it was 51 out of 799 (6.4 percent).

Communications and Information Officers (33SX) Graduate Degree Comparison

The observed frequency table for communications and information officers is found in Appendix M and the percentages are found in Appendix N. The overall number of communications and information officers with graduate degrees decreased from 4,777 to 2,150 for an overall decrease of 55.0 percent. The number of non-technical degrees decreased from 3,775 in 1990 (79.0 percent of all communications and information degrees) to 1,634 in 2000 (76 percent of all communications and information degrees) for an overall decrease of 3.0 points. The number of technical degrees decreased from 1,002 in 1990 (21.0 percent of all communications and information degrees) to 516 in 2000 (24 percent of all communications and information degrees) for an overall increase of 3.0 points.

The calculated chi-square test value of 7.750257 (See Appendix Q) exceeds the critical test value of 3.84146 and this shift is therefore statistically significant. The career

field of command, control, communications and computers was combined with the information management career field in 1996 by USAF Program Action Directive 96-03 to form one career field called communications and information. In order to account for this, the 1990 data factored both separate career fields (communications/computers and information management) and combined them into the analysis. This ensured that the same career fields in 1990 and 2000 were being compared. Computer science/data processing increased by 3.0 points. Electrical engineering decreased by 1.6 points while the information resource management degree increased by 13.5 points. General Engineering increased by 1.3 points. Education decreased by 3.3 points and human resource management decreased by 2.5 points. In 1990, the number of communications and information officer data discrepancies was 301 out of 4777 (6.3 percent) and in 2000, there were 315 discrepancies out of 2,150 data points (14.7 percent).

Chapter Summary

This chapter summarized the findings of this study. It first examined the results Air Force-wide and found there has been no statistical change in the percentage of technical graduate degrees. It then specifically discussed senior leadership (colonel through general) and also found no statistically significant change in the percentage of technical graduate degrees. It then examined 6 individual career fields. No statistical change was found in the following career fields: scientists and developmental engineers. A statistical increase in the percentage of technical graduate degrees was found in the following career fields: pilots, civil engineers, communications and information officers, and acquisition managers.

V. Conclusions and Recommendations

Chapter Overview

This chapter discusses the conclusions of this study. It also discusses recommendations based on these results. It then discusses the limitations encountered in accomplishing this study. Implications for both researchers and managers are then analyzed. Finally, it offers possible areas of further research.

Conclusions

Based on the analysis of the AFPC data and the results summarized in Chapter IV, this study concludes there has not been a significant overall decrease in the percentage of United States Air Force line officers with technical graduate degrees. Conversely, it concludes there has been a slight increase in the percentage of overall Air Force line officers with technical degrees. In addition, it also concludes that there has been no significant change in the percentage of senior officers with technical graduate degrees. It concludes the following career fields have actually increased in the percentage of officers with technical graduate education: pilots (2.5 points), civil engineers (9.1 points), communications and information officers (3.0 points) and acquisition managers (6.3 points). Although scientists and developmental engineers increased in technical degree percentages, both did not significantly change statistically.

Limitations to Accomplishing this Study

One major limitation to the accomplishment of this study was the availability of the data. The data is maintained by AFPC and was accessed through a search by an individual at AFIT who was designated by AFPC as having authority to access the database. Although historical data earlier than 1990 does exist, it is unclear if it is accurate for those fields addressed in this study (highest degree, highest institution, Primary and Secondary AFSCs, etc.). In addition, the earlier data is kept in a separate database that is much more difficult to access without AFPC assistance. When help was requested from AFPC to access the data, AFPC claimed they were not manned to help AFIT students and refused.

Another major limitation was obtaining the data for senior officers (Colonel through General). A normal AFPC database search can only be accomplished on the ranks of 2 Lt. through Lt. Colonel. All access to the Colonel (O-6) information is controlled by the Colonel's Group and all access to the General (O-7 through O-10) information is controlled by the General's Group. Both Groups are located at the Pentagon. Approval of the release of this information took almost 3 months even though no specific names or social security numbers were requested.

Related to the data limitations, in 1993 there was a change of AFSC codes. Prior to November 1993, all AFSC were 4 digit numerical codes that did not have any letters. For example, the AFSC of civil engineers is currently 32EX. Prior to 1993, the same AFSC was 5521. For this study, all 1990 data points had to be translated into current AFSCs in order to accomplish the comparisons. This required a listing of all former AFSCs and what they had been changed to and all current AFSCs and what they had

been prior to the change in 1993. During this conversion process, some data points may have been either lost or incorrectly coded.

Primary and secondary AFSCs also created a limitation to this study. As mentioned in Chapters III and IV, the data only lists primary and secondary AFSCs. It is unclear what AFSCs they were operating in when they earned their degrees. Although inferences can be made based on the other attributes, there is no specific method in determining what career field to place the officers in and judgment call must be made. Although there are several ways to specifically determine what career fields the officers are in such as contacting the functional managers at AFPC or contacting the officers directly, but these methods would be extremely time consuming and this cost would probably not outweigh the benefit.

Another limitation to this accomplishing this study was determining what degrees are classified as technical and what degrees as classified as nontechnical. A search of the literature did not reveal accepted criteria to determine the definition of the degrees. In addition, the Air Force does not officially define technical versus nontechnical degrees. Although this study did use AFI 36-2205 as criteria, this instruction is for requirements of astronauts and may or not may not be applicable to the Air Force as a whole. Others may disagree with the use of this instruction as criteria and may have their own criteria for what they feel is technical and what is nontechnical.

Another limitation is the titles of the degrees and what category they were placed in. Many degree titles sound very technical but in reality are not technical and a judgment call had to be made in terms of the category. For example, Webster University offers degrees in space operations, but Webster University does not offer technical

graduate degrees. Institutions such as MIT and AFIT offer graduate degrees in space operations that are very technically oriented and a degree in space operations from these institutions is not the same as a degree in space operations from Webster University. Therefore, the officers with degrees from Webster were placed in the non-technical space studies degree while the officers with degrees from AFIT and MIT were placed in the technical space operations category. This limitation also applied to degrees such as systems analysis/management versus systems engineering.

Implications for Researchers

Due to the limitations concerning the data mentioned above, there are several implications for researchers. One major implication is the difficulty in obtaining the data. It will be extremely difficult for a researcher outside the Air Force to obtain the information regarding senior Air Force officers. Those researchers inside the Air Force must allow ample time for approval of the release of the information. In addition, it is possible that access to the historical database by Air Force researchers will require senior leadership coordination to facilitate AFPC's assistance.

Another implication is the conversion of historical data prior to 1993 requires a conversion list. There is no official condensed conversion list provided by the Air Force and this conversion data must be obtained either through AFPC or someone who was in the Air Force during the time of the conversion. Sorting through this extensive list and the conversion of the data also takes considerable time and ample time should be allowed during this process.

Criteria for the definition of nontechnical and technical degrees must also be decided upon. Although an accepted list of criteria was not found, this does mean one does not exist and a more detailed search of the literature will be required. In addition, the researcher must also be careful when examining the degree titles. The degree titles have changed in the past 10 years and could continue to change in the future as well. This will require the researcher to make judgment calls when placing certain degrees in the two categories (non-technical versus technical).

Implications for Managers and Recommendations

Although senior leadership is concerned about technical graduate education, this study provides evidence that there has not been an overall decrement of technical graduate educations in the United States Air Force line officer corps in the last 10 years. Although the Air Force has substantially decreased in size, the types and percentages of graduate degrees of Air Force officers do not significantly differ from 1990 to 2000. Although the levels have not changed, the current levels may not be adequate enough. If senior Air Force leadership feels the current levels of technical and non-technical graduate degrees are enough, the implication of this study is to continue the current process of graduate education management. If senior Air Force leadership does not feel the current levels of technical and non-technical graduate degrees are adequate, the implication of this study is to examine what areas or career fields they feel are lacking and implement future solutions to correct the problem.

In addition, to overall implications and recommendations, this study proposes several recommendations for specific career fields and degrees. Due to the

aforementioned combining of the communications and information manager career fields in 1996, there has been an overall 3.0 point shift to nontechnical degrees. However, the information resource management degree has increased by 13.5 points. The officers in this career field may or may not need a technical degree and this study therefore recommends that the communications and information career field managers analyze the graduate degrees they feel are required for their officers to operate effectively in this career field. In his 1999 AFIT thesis, Little explored the requirements for additional training of communications and information officers. He established training areas and categories and this work could possibly be a good start in determining graduate degree requirements. Because technology is changing at such a rapid pace, this study also recommends that all career field managers conduct similar studies to analyze the duties and requirements of their individual career fields and determine the requirements they feel are necessary for their officers.

In addition, the degree of aeroscience technology/studies has seen a huge jump overall (2,397 (5.8 percent overall) to 4,430 (16.0 percent overall)) and in specific career fields including senior leadership, pilots, developmental engineers, and acquisition managers. The majority of these degrees are offered by Embry-Riddle University. The useful value of this degree to Air Force officers should also be examined. This examination could include a curriculum review and surveys of officers with such a degree. Finally, this study recommends that Air Force senior leadership continue to monitor the graduate degrees earned by its officers in the future.

Possible Areas of Further Research

Although this study compared graduate education of Air Force officers in 1990 and 2000, it does not show specifically what circumstances may have caused the results found in this study. An impact analysis to determine the causes would be appropriate. One possible method would be a survey of Air Force officers' views on graduate education and their feeling on technical versus nontechnical graduate degrees. This survey would not only aid in determining if senior Air Force leadership efforts are working in ensuring competent, technically educated officers, but could also determine officer motivations for achieving specific degrees.

Another possible area of research would be a study similar to this one using older data. It is unclear from this study if there has been a shift from technical to nontechnical degrees during the late 1970s when many Air Force officers were declining technical degrees. There could have been a significant change from this time until the present.

Although this study did not find any significant overall changes in graduate degrees from 1990 to 2000, it only used these two years in the analysis. There may have been changes during these years and a trend analysis would be effective in analyzing each year between 1990 and 2000. In addition, a trend analysis using older data up until the present would also be an effective way to analyze graduate degrees in the Air Force.

A final area of possible research would be to determine what levels of technical graduate education are enough for individual career fields. This study showed no significant increase in the scientists, but does not address if the current levels are enough. For example, ideally all Air Force scientists would have technical degrees in their fields of study. Currently, 82 percent have technical degrees, but is that enough? A study of

the graduate degrees of civilian scientists involved in research and development might provide insight into this question.

Chapter Summary

This chapter addressed the conclusions and recommendations of this study. It began by specifically discussing the final conclusions based on the data. Limitations to accomplishing this study were discussed followed by implications for both managers and researchers. It then addressed the recommendations to senior Air Force leadership and other affected Air Force organizations. Finally, it discussed possible areas of research and suggested possible studies related to this research effort.

Appendix A: Overall Observed Table

Degree	1990	2000
Acquisition/Logistics	1157	787
Aeroscience Technology/Studies	2397	4430
Area Studies	451	305
MBA	12147	6994
Cost Analysis	79	105
Criminology/Forensics	317	249
Economics	174	185
Education	1813	790
Engineering Management	538	413
Fine and Applied Arts	101	45
General/Liberal Studies	205	93
Geography	52	35
History	306	293
Human Resource Management	2056	1220
Industrial Technology	80	90
Information Resource Management	486	903
Language (Public Relations)	341	203
Military Arts and Science	109	126
Political Science	1779	1167
Procurement Management	190	132
Psychology	1774	612
Public Administration	3124	1535
Social Sciences	47	28
Sociology	111	38
Space Studies	83	319
Strategic Intelligence	65	187
Systems Management/Analysis	2734	821
Systems Technology, C3I	91	42
Telecommunications/Teleprocessing	235	85
Other Nontechnical	381	217
Nontechnical Total	33423	22449
Aeronautical/Astronautical Engineering	1172	882
Analysis and Forecasting	82	58
Biology	163	101
Chemistry	173	94
Civil Engineering	305	415
Computer Science/Data Processing	1039	622
Electrical Engineering	1553	624
General Engineering	57	351
Industrial Engineering	173	155
Math/Numerical Methods in Computing	315	181
Mechanical Engineering	406	407
Meteorology	498	307
Nuclear Engineering	100	37
Operations Research	702	426
Physics	389	240
Research and Development Mgmt.	74	24
Space Operations	217	209
Systems Engineering	118	79
Other Technical	214	82
Technical Total	7750	5294
Overall Total	41173	27743

Appendix B: Overall Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.028	0.028	0.000
Aeroscience Technology/Studies	0.058	0.160	0.101
Area Studies	0.011	0.011	0.000
MBA	0.295	0.252	-0.043
Cost Analysis	0.002	0.004	0.002
Criminology/Forensics	0.008	0.009	0.001
Economics	0.004	0.007	0.002
Education	0.044	0.028	-0.016
Engineering Management	0.013	0.015	0.002
Fine and Applied Arts	0.002	0.002	-0.001
General/Liberal Studies	0.005	0.003	-0.002
Geography	0.001	0.001	0.000
History	0.007	0.011	0.003
Human Resource Management	0.050	0.044	-0.006
Industrial Technology	0.002	0.003	0.001
Information Resource Management	0.012	0.033	0.021
Language (Public Relations)	0.008	0.007	-0.001
Military Arts and Science	0.003	0.005	0.002
Political Science	0.043	0.042	-0.001
Procurement Management	0.005	0.005	0.000
Psychology	0.043	0.022	-0.021
Public Administration	0.076	0.055	-0.021
Social Sciences	0.001	0.001	0.000
Sociology	0.003	0.001	-0.001
Space Studies	0.002	0.011	0.009
Strategic Intelligence	0.002	0.007	0.005
Systems Management/Analysis	0.066	0.030	-0.037
Systems Technology, C3I	0.002	0.002	-0.001
Telecommunications/Teleprocessing	0.006	0.003	-0.003
Other Nontechnical	0.009	0.008	-0.001
Nontechnical Total	0.812	0.809	-0.003
Aeronautical/Astronautical Engineering	0.028	0.032	0.003
Analysis and Forecasting	0.002	0.002	0.000
Biology	0.004	0.004	0.000
Chemistry	0.004	0.003	-0.001
Civil Engineering	0.007	0.015	0.008
Computer Science/Data Processing	0.025	0.022	-0.003
Electrical Engineering	0.038	0.022	-0.015
General Engineering	0.001	0.013	0.011
Industrial Engineering	0.004	0.006	0.001
Math/Numerical Methods in Computing	0.008	0.007	-0.001
Mechanical Engineering	0.010	0.015	0.005
Meteorology	0.012	0.011	-0.001
Nuclear Engineering	0.002	0.001	-0.001
Operations Research	0.017	0.015	-0.002
Physics	0.009	0.009	-0.001
Research and Development Mgmt.	0.002	0.001	-0.001
Space Operations	0.005	0.008	0.002
Systems Engineering	0.003	0.003	0.000
Other Technical	0.005	0.003	-0.002
Technical Total	0.188	0.191	0.003
Overall Total	1	1	

Appendix C: Senior Leadership Observed Table

Degree	1990	2000
Acquisition/Logistics	149	96
Aeroscience Technology/Studies	21	147
Area Studies	72	28
MBA	1462	1102
Cost Analysis	0	0
Criminology/Forensics	24	25
Economics	29	11
Education	259	131
Engineering Management	49	38
Fine and Applied Arts	0	0
General/Liberal Studies	14	9
Geography	3	3
History	30	51
Human Resource Management	194	167
Industrial Technology	0	0
Information Resource Management	0	21
Language (Public Relations)	50	34
Military Arts and Science	23	39
Political Science	296	189
Procurement Management	9	16
Psychology	273	133
Public Administration	413	275
Social Sciences	13	10
Sociology	17	12
Space Studies	0	0
Strategic Intelligence	0	0
Systems Management/Analysis	282	225
Systems Technology, C3I	0	0
Telecommunications/Teleprocessing	22	14
Other Nontechnical	18	28
Nontechnical Total	3722	2804
Aeronautical/Astronautical Engineering	131	81
Analysis and Forecasting	12	4
Biology	10	13
Chemistry	10	17
Civil Engineering	57	39
Computer Science/Data Processing	45	46
Electrical Engineering	73	54
General Engineering	3	1
Industrial Engineering	28	26
Math/Numerical Methods in Computing	24	16
Mechanical Engineering	29	33
Meteorology	24	16
Nuclear Engineering	7	3
Operations Research	29	45
Physics	31	31
Research and Development Mgmt.	22	5
Space Operations	0	14
Systems Engineering	34	17
Other Technical	13	20
Technical Total	582	481
Overall Total	4304	3285

Appendix D: Senior Leadership Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.035	0.029	-0.005
Aeroscience Technology/Studies	0.005	0.045	0.040
Area Studies	0.017	0.009	-0.008
MBA	0.340	0.335	-0.004
Cost Analysis	0.000	0.000	0.000
Criminology/Forensics	0.006	0.008	0.002
Economics	0.007	0.003	-0.003
Education	0.060	0.040	-0.020
Engineering Management	0.011	0.012	0.000
Fine and Applied Arts	0.000	0.000	0.000
General/Liberal Studies	0.003	0.003	-0.001
Geography	0.001	0.001	0.000
History	0.007	0.016	0.009
Human Resource Management	0.045	0.051	0.006
Industrial Technology	0.000	0.000	0.000
Information Resource Management	0.000	0.006	0.006
Language (Public Relations)	0.012	0.010	-0.001
Military Arts and Science	0.005	0.012	0.007
Political Science	0.069	0.058	-0.011
Procurement Management	0.002	0.005	0.003
Psychology	0.063	0.040	-0.023
Public Administration	0.096	0.084	-0.012
Social Sciences	0.003	0.003	0.000
Sociology	0.004	0.004	0.000
Space Studies	0.000	0.000	0.000
Strategic Intelligence	0.000	0.000	0.000
Systems Management/Analysis	0.066	0.068	0.003
Systems Technology, C3I	0.000	0.000	0.000
Telecommunications/Teleprocessing	0.005	0.004	-0.001
Other Nontechnical	0.004	0.009	0.004
Nontechnical Total	0.865	0.854	-0.011
Aeronautical/Astronautical Engineering	0.030	0.025	-0.006
Analysis and Forecasting	0.003	0.001	-0.002
Biology	0.002	0.004	0.002
Chemistry	0.002	0.005	0.003
Civil Engineering	0.013	0.012	-0.001
Computer Science/Data Processing	0.010	0.014	0.004
Electrical Engineering	0.017	0.016	-0.001
General Engineering	0.001	0.000	0.000
Industrial Engineering	0.007	0.008	0.001
Math/Numerical Methods in Computing	0.006	0.005	-0.001
Mechanical Engineering	0.007	0.010	0.003
Meteorology	0.006	0.005	-0.001
Nuclear Engineering	0.002	0.001	-0.001
Operations Research	0.007	0.014	0.007
Physics	0.007	0.009	0.002
Research and Development Mgmt.	0.005	0.002	-0.004
Space Operations	0.000	0.004	0.004
Systems Engineering	0.008	0.005	-0.003
Other Technical	0.003	0.006	0.003
Technical Total	0.135	0.146	0.011
Overall Total	1	1	

Appendix E: Pilot (11XX) Observed Table

Degree	1990	2000
Acquisition/Logistics	78	88
Aeroscience Technology/Studies	1105	2312
Area Studies	63	22
MBA	2668	1326
Cost Analysis	4	2
Criminology/Forensics	11	15
Economics	32	31
Education	268	128
Engineering Management	47	53
Fine and Applied Arts	8	4
General/Liberal Studies	46	20
Geography	7	10
History	61	79
Human Resource Management	515	225
Industrial Technology	17	14
Information Resource Management	38	131
Language (Public Relations)	20	10
Military Arts and Science	53	29
Political Science	479	329
Procurement Management	18	12
Psychology	365	93
Public Administration	544	249
Social Sciences	11	10
Sociology	14	3
Space Studies	3	19
Strategic Intelligence	1	20
Systems Management/Analysis	543	87
Systems Technology, C3I	4	3
Telecommunications/Teleprocessing	3	3
Other Nontechnical	54	26
Nontechnical Total	7080	5353
Aeronautical/Astronautical Engineering	196	237
Analysis and Forecasting	6	0
Biology	30	25
Chemistry	24	13
Civil Engineering	37	42
Computer Science/Data Processing	85	55
Electrical Engineering	82	77
General Engineering	4	50
Industrial Engineering	9	21
Math/Numerical Methods in Computing	29	31
Mechanical Engineering	73	118
Meteorology	8	6
Nuclear Engineering	5	4
Operations Research	177	76
Physics	25	32
Research and Development Mgmt.	8	0
Space Operations	21	16
Systems Engineering	8	6
Other Technical	22	3
Technical Total	849	812
Overall Total	7929	6165

Appendix F: Pilot (11XX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.010	0.014	0.004
Aeroscience Technology/Studies	0.139	0.375	0.236
Area Studies	0.008	0.004	-0.004
MBA	0.336	0.215	-0.121
Cost Analysis	0.001	0.000	0.000
Criminology/Forensics	0.001	0.002	0.001
Economics	0.004	0.005	0.001
Education	0.034	0.021	-0.013
Engineering Management	0.006	0.009	0.003
Fine and Applied Arts	0.001	0.001	0.000
General/Liberal Studies	0.006	0.003	-0.003
Geography	0.001	0.002	0.001
History	0.008	0.013	0.005
Human Resource Management	0.065	0.036	-0.028
Industrial Technology	0.002	0.002	0.000
Information Resource Management	0.005	0.021	0.016
Language (Public Relations)	0.003	0.002	-0.001
Military Arts and Science	0.007	0.005	-0.002
Political Science	0.060	0.053	-0.007
Procurement Management	0.002	0.002	0.000
Psychology	0.046	0.015	-0.031
Public Administration	0.069	0.040	-0.028
Social Sciences	0.001	0.002	0.000
Sociology	0.002	0.000	-0.001
Space Studies	0.000	0.003	0.003
Strategic Intelligence	0.000	0.003	0.003
Systems Management/Analysis	0.068	0.014	-0.054
Systems Technology, C3I	0.001	0.000	0.000
Telecommunications/Teleprocessing	0.000	0.000	0.000
Other Nontechnical	0.007	0.004	-0.003
Nontechnical Total	0.893	0.868	-0.025
Aeronautical/Astronautical Engineering	0.025	0.038	0.014
Analysis and Forecasting	0.001	0.000	-0.001
Biology	0.004	0.004	0.000
Chemistry	0.003	0.002	-0.001
Civil Engineering	0.005	0.007	0.002
Computer Science/Data Processing	0.011	0.009	-0.002
Electrical Engineering	0.010	0.012	0.002
General Engineering	0.001	0.008	0.008
Industrial Engineering	0.001	0.003	0.002
Math/Numerical Methods in Computing	0.004	0.005	0.001
Mechanical Engineering	0.009	0.019	0.010
Meteorology	0.001	0.001	0.000
Nuclear Engineering	0.001	0.001	0.000
Operations Research	0.022	0.012	-0.010
Physics	0.003	0.005	0.002
Research and Development Mgmt.	0.001	0.000	-0.001
Space Operations	0.003	0.003	0.000
Systems Engineering	0.001	0.001	0.000
Other Technical	0.003	0.000	-0.002
Technical Total	0.107	0.132	0.025
Overall Total	1	1	

Appendix G: Civil Engineer (32EX) Observed Table

Degree	1990	2000
Acquisition/Logistics	1	6
Aeroscience Technology/Studies	13	14
Area Studies	1	0
MBA	235	155
Cost Analysis	0	0
Criminology/Forensics	0	0
Economics	0	2
Education	7	8
Engineering Management	229	124
Fine and Applied Arts	3	2
General/Liberal Studies	1	0
Geography	0	0
History	0	0
Human Resource Management	18	12
Industrial Technology	0	1
Information Resource Management	12	6
Language (Public Relations)	0	1
Military Arts and Science	1	1
Political Science	12	10
Procurement Management	5	2
Psychology	3	3
Public Administration	58	45
Social Sciences	1	0
Sociology	0	0
Space Studies	0	1
Strategic Intelligence	0	0
Systems Management/Analysis	62	19
Systems Technology, C3I	0	0
Telecommunications/Teleprocessing	0	0
Other Nontechnical	1	4
Nontechnical Total	663	416
Aeronautical/Astronautical Engineering	16	6
Analysis and Forecasting	1	0
Biology	0	2
Chemistry	0	0
Civil Engineering	216	300
Computer Science/Data Processing	3	1
Electrical Engineering	39	8
General Engineering	0	6
Industrial Engineering	31	12
Math/Numerical Methods in Computing	1	0
Mechanical Engineering	41	19
Meteorology	0	0
Nuclear Engineering	0	0
Operations Research	17	1
Physics	0	0
Research and Development Mgmt.	0	1
Space Operations	0	1
Systems Engineering	0	2
Other Technical	56	24
Technical Total	421	383
Overall Total	1084	799

Appendix H: Civil Engineer (32EX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.001	0.008	0.007
Aeroscience Technology/Studies	0.012	0.018	0.006
Area Studies	0.001	0.000	-0.001
MBA	0.217	0.194	-0.023
Cost Analysis	0.000	0.000	0.000
Criminology/Forensics	0.000	0.000	0.000
Economics	0.000	0.003	0.003
Education	0.006	0.010	0.004
Engineering Management	0.211	0.155	-0.056
Fine and Applied Arts	0.003	0.003	0.000
General/Liberal Studies	0.001	0.000	-0.001
Geography	0.000	0.000	0.000
History	0.000	0.000	0.000
Human Resource Management	0.017	0.015	-0.002
Industrial Technology	0.000	0.001	0.001
Information Resource Management	0.011	0.008	-0.004
Language (Public Relations)	0.000	0.001	0.001
Military Arts and Science	0.001	0.001	0.000
Political Science	0.011	0.013	0.001
Procurement Management	0.005	0.003	-0.002
Psychology	0.003	0.004	0.001
Public Administration	0.054	0.056	0.003
Social Sciences	0.001	0.000	-0.001
Sociology	0.000	0.000	0.000
Space Studies	0.000	0.001	0.001
Strategic Intelligence	0.000	0.000	0.000
Systems Management/Analysis	0.057	0.024	-0.033
Systems Technology, C3I	0.000	0.000	0.000
Telecommunications/Teleprocessing	0.000	0.000	0.000
Other Nontechnical	0.001	0.005	0.004
Nontechnical Total	0.612	0.521	-0.091
Aeronautical/Astronautical Engineering	0.015	0.008	-0.007
Analysis and Forecasting	0.001	0.000	-0.001
Biology	0.000	0.003	0.003
Chemistry	0.000	0.000	0.000
Civil Engineering	0.199	0.375	0.176
Computer Science/Data Processing	0.003	0.001	-0.002
Electrical Engineering	0.036	0.010	-0.026
General Engineering	0.000	0.008	0.008
Industrial Engineering	0.029	0.015	-0.014
Math/Numerical Methods in Computing	0.001	0.000	-0.001
Mechanical Engineering	0.038	0.024	-0.014
Meteorology	0.000	0.000	0.000
Nuclear Engineering	0.000	0.000	0.000
Operations Research	0.016	0.001	-0.014
Physics	0.000	0.000	0.000
Research and Development Mgmt.	0.000	0.001	0.001
Space Operations	0.000	0.001	0.001
Systems Engineering	0.000	0.003	0.003
Other Technical	0.052	0.030	-0.022
Technical Total	0.388	0.479	0.091
Overall Total	1	1	

Appendix I: Communications and Information (33SX) Observed Table

Degree	1990	2000
Acquisition/Logistics	47	10
Aeroscience Technology/Studies	87	61
Area Studies	18	4
MBA	1334	585
Cost Analysis	0	1
Criminology/Forensics	9	6
Economics	8	6
Education	242	38
Engineering Management	25	18
Fine and Applied Arts	12	1
General/Liberal Studies	13	6
Geography	0	1
History	23	6
Human Resource Management	263	65
Industrial Technology	8	7
Information Resource Management	284	419
Language (Public Relations)	35	6
Military Arts and Science	3	1
Political Science	126	41
Procurement Management	27	8
Psychology	195	36
Public Administration	315	74
Social Sciences	1	0
Sociology	18	2
Space Studies	8	18
Strategic Intelligence	1	4
Systems Management/Analysis	375	114
Systems Technology, C3I	47	23
Telecommunications/Teleprocessing	219	59
Other Non Technical	32	14
Non-Technical Total	3775	1634
Aeronautical/Astronautical Engineering	3	9
Analysis and Forecasting	1	0
Biology	13	2
Chemistry	6	1
Civil Engineering	0	4
Computer Science/Data Processing	577	325
Electrical Engineering	201	57
General Engineering	2	28
Industrial Engineering	8	8
Math/Numerical Methods in Computing	130	40
Mechanical Engineering	5	2
Meteorology	0	2
Nuclear Engineering	0	1
Operations Research	28	19
Physics	4	2
Research and Development Mgmt.	3	1
Space Operations	10	4
Systems Engineering	4	6
Other Technical	7	5
Technical Total	1002	516
Overall Total	4777	2150

Appendix J: Communications and Information (33SX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.010	0.005	-0.005
Aeroscience Technology/Studies	0.018	0.028	0.010
Area Studies	0.004	0.002	-0.002
MBA	0.279	0.272	-0.007
Cost Analysis	0.000	0.000	0.000
Criminology/Forensics	0.002	0.003	0.001
Economics	0.002	0.003	0.001
Education	0.051	0.018	-0.033
Engineering Management	0.005	0.008	0.003
Fine and Applied Arts	0.003	0.000	-0.002
General/Liberal Studies	0.003	0.003	0.000
Geography	0.000	0.000	0.000
History	0.005	0.003	-0.002
Human Resource Management	0.055	0.030	-0.025
Industrial Technology	0.002	0.003	0.002
Information Resource Management	0.059	0.195	0.135
Language (Public Relations)	0.007	0.003	-0.005
Military Arts and Science	0.001	0.000	0.000
Political Science	0.026	0.019	-0.007
Procurement Management	0.006	0.004	-0.002
Psychology	0.041	0.017	-0.024
Public Administration	0.066	0.034	-0.032
Social Sciences	0.000	0.000	0.000
Sociology	0.004	0.001	-0.003
Space Studies	0.002	0.008	0.007
Strategic Intelligence	0.000	0.002	0.002
Systems Management/Analysis	0.079	0.053	-0.025
Systems Technology, C3I	0.010	0.011	0.001
Telecommunications/Teleprocessing	0.046	0.027	-0.018
Other Nontechnical	0.007	0.007	0.000
Nontechnical Total	0.790	0.760	-0.030
Aeronautical/Astronautical Engineering	0.001	0.004	0.004
Analysis and Forecasting	0.000	0.000	0.000
Biology	0.003	0.001	-0.002
Chemistry	0.001	0.000	-0.001
Civil Engineering	0.000	0.002	0.002
Computer Science/Data Processing	0.121	0.151	0.030
Electrical Engineering	0.042	0.027	-0.016
General Engineering	0.000	0.013	0.013
Industrial Engineering	0.002	0.004	0.002
Math/Numerical Methods in Computing	0.027	0.019	-0.009
Mechanical Engineering	0.001	0.001	0.000
Meteorology	0.000	0.001	0.001
Nuclear Engineering	0.000	0.000	0.000
Operations Research	0.006	0.009	0.003
Physics	0.001	0.001	0.000
Research and Development Mgmt.	0.001	0.000	0.000
Space Operations	0.002	0.002	0.000
Systems Engineering	0.001	0.003	0.002
Other Technical	0.001	0.002	0.001
Technical Total	0.210	0.240	0.030
Overall Total	1	1	

Appendix K: Scientist (61SX) Observed Table

Degree	1990	2000
Acquisition/Logistics	0	2
Aeroscience Technology/Studies	2	5
Area Studies	1	0
MBA	46	30
Cost Analysis	0	0
Criminology/Forensics	1	0
Economics	9	3
Education	9	6
Engineering Management	11	4
Fine and Applied Arts	0	0
General/Liberal Studies	1	0
Geography	0	1
History	0	0
Human Resource Management	3	3
Industrial Technology	0	1
Information Resource Management	3	7
Language (Public Relations)	0	0
Military Arts and Science	0	1
Political Science	2	2
Procurement Management	1	0
Psychology	104	35
Public Administration	6	2
Social Sciences	0	0
Sociology	1	4
Space Studies	0	4
Strategic Intelligence	0	0
Systems Management/Analysis	26	5
Systems Technology, C3I	11	1
Telecommunications/Teleprocessing	0	0
Other Nontechnical	2	0
Nontechnical Total	239	116
Aeronautical/Astronautical Engineering	6	7
Analysis and Forecasting	10	0
Biology	20	22
Chemistry	84	45
Civil Engineering	1	1
Computer Science/Data Processing	25	7
Electrical Engineering	12	6
General Engineering	2	11
Industrial Engineering	29	17
Math/Numerical Methods in Computing	49	42
Mechanical Engineering	4	6
Meteorology	2	0
Nuclear Engineering	73	25
Operations Research	248	181
Physics	265	135
Research and Development Mgmt.	0	0
Space Operations	0	4
Systems Engineering	0	7
Other Technical	10	6
Technical Total	840	522
Overall Total	1079	638

Appendix L: Scientist (61SX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.000	0.003	0.003
Aeroscience Technology/Studies	0.002	0.008	0.006
Area Studies	0.001	0.000	-0.001
MBA	0.043	0.047	0.004
Cost Analysis	0.000	0.000	0.000
Criminology/Forensics	0.001	0.000	-0.001
Economics	0.008	0.005	-0.004
Education	0.008	0.009	0.001
Engineering Management	0.010	0.006	-0.004
Fine and Applied Arts	0.000	0.000	0.000
General/Liberal Studies	0.001	0.000	-0.001
Geography	0.000	0.002	0.002
History	0.000	0.000	0.000
Human Resource Management	0.003	0.005	0.002
Industrial Technology	0.000	0.002	0.002
Information Resource Management	0.003	0.011	0.008
Language (Public Relations)	0.000	0.000	0.000
Military Arts and Science	0.000	0.002	0.002
Political Science	0.002	0.003	0.001
Procurement Management	0.001	0.000	-0.001
Psychology	0.096	0.055	-0.042
Public Administration	0.006	0.003	-0.002
Social Sciences	0.000	0.000	0.000
Sociology	0.001	0.006	0.005
Space Studies	0.000	0.006	0.006
Strategic Intelligence	0.000	0.000	0.000
Systems Management/Analysis	0.024	0.008	-0.016
Systems Technology, C3I	0.010	0.002	-0.009
Telecommunications/Teleprocessing	0.000	0.000	0.000
Other Nontechnical	0.002	0.000	-0.002
Nontechnical Total	0.222	0.182	-0.040
Aeronautical/Astronautical Engineering	0.006	0.011	0.005
Analysis and Forecasting	0.009	0.000	-0.009
Biology	0.019	0.034	0.016
Chemistry	0.078	0.071	-0.007
Civil Engineering	0.001	0.002	0.001
Computer Science/Data Processing	0.023	0.011	-0.012
Electrical Engineering	0.011	0.009	-0.002
General Engineering	0.002	0.017	0.015
Industrial Engineering	0.027	0.027	0.000
Math/Numerical Methods in Computing	0.045	0.066	0.020
Mechanical Engineering	0.004	0.009	0.006
Meteorology	0.002	0.000	-0.002
Nuclear Engineering	0.068	0.039	-0.028
Operations Research	0.230	0.284	0.054
Physics	0.246	0.212	-0.034
Research and Development Mgmt.	0.000	0.000	0.000
Space Operations	0.000	0.006	0.006
Systems Engineering	0.000	0.011	0.011
Other Technical	0.009	0.009	0.000
Technical Total	0.778	0.818	0.040
Overall Total	1	1	

Appendix M: Developmental Engineer(62EX) Observed Table

Degree	1990	2000
Acquisition/Logistics	12	5
Aeroscience Technology/Studies	38	35
Area Studies	0	3
MBA	381	159
Cost Analysis	0	1
Criminology/Forensics	0	0
Economics	5	1
Education	6	6
Engineering Management	86	43
Fine and Applied Arts	1	0
General/Liberal Studies	1	0
Geography	0	0
History	0	1
Human Resource Management	26	8
Industrial Technology	1	2
Information Resource Management	11	7
Language (Public Relations)	0	2
Military Arts and Science	2	1
Political Science	20	7
Procurement Management	5	3
Psychology	5	5
Public Administration	20	6
Social Sciences	0	0
Sociology	0	0
Space Studies	3	15
Strategic Intelligence	1	2
Systems Management/Analysis	253	61
Systems Technology, C3I	1	0
Telecommunications/Teleprocessing	1	3
Other Nontechnical	6	2
Nontechnical Total	885	378
Aeronautical/Astronautical Engineering	766	349
Analysis and Forecasting	1	0
Biology	4	5
Chemistry	10	5
Civil Engineering	5	6
Computer Science/Data Processing	127	75
Electrical Engineering	1047	319
General Engineering	32	134
Industrial Engineering	20	20
Math/Numerical Methods in Computing	23	10
Mechanical Engineering	197	129
Meteorology	2	0
Nuclear Engineering	9	2
Operations Research	28	12
Physics	19	14
Research and Development Mgmt.	14	1
Space Operations	10	15
Systems Engineering	90	21
Other Technical	27	7
Technical Total	2431	1124
Overall Total	3316	1502

Appendix N: Developmental Engineer (62EX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.004	0.003	0.000
Aeroscience Technology/Studies	0.011	0.023	0.012
Area Studies	0.000	0.002	0.002
MBA	0.115	0.106	-0.009
Cost Analysis	0.000	0.001	0.001
Criminology/Forensics	0.000	0.000	0.000
Economics	0.002	0.001	-0.001
Education	0.002	0.004	0.002
Engineering Management	0.026	0.029	0.003
Fine and Applied Arts	0.000	0.000	0.000
General/Liberal Studies	0.000	0.000	0.000
Geography	0.000	0.000	0.000
History	0.000	0.001	0.001
Human Resource Management	0.008	0.005	-0.003
Industrial Technology	0.000	0.001	0.001
Information Resource Management	0.003	0.005	0.001
Language (Public Relations)	0.000	0.001	0.001
Military Arts and Science	0.001	0.001	0.000
Political Science	0.006	0.005	-0.001
Procurement Management	0.002	0.002	0.000
Psychology	0.002	0.003	0.002
Public Administration	0.006	0.004	-0.002
Social Sciences	0.000	0.000	0.000
Sociology	0.000	0.000	0.000
Space Studies	0.001	0.010	0.009
Strategic Intelligence	0.000	0.001	0.001
Systems Management/Analysis	0.076	0.041	-0.036
Systems Technology, C3I	0.000	0.000	0.000
Telecommunications/Teleprocessing	0.000	0.002	0.002
Other Nontechnical	0.002	0.001	0.000
Nontechnical Total	0.267	0.252	-0.015
Aeronautical/Astronautical Engineering	0.231	0.232	0.001
Analysis and Forecasting	0.000	0.000	0.000
Biology	0.001	0.003	0.002
Chemistry	0.003	0.003	0.000
Civil Engineering	0.002	0.004	0.002
Computer Science/Data Processing	0.038	0.050	0.012
Electrical Engineering	0.316	0.212	-0.103
General Engineering	0.010	0.089	0.080
Industrial Engineering	0.006	0.013	0.007
Math/Numerical Methods in Computing	0.007	0.007	0.000
Mechanical Engineering	0.059	0.086	0.026
Meteorology	0.001	0.000	-0.001
Nuclear Engineering	0.003	0.001	-0.001
Operations Research	0.008	0.008	0.000
Physics	0.006	0.009	0.004
Research and Development Mgmt.	0.004	0.001	-0.004
Space Operations	0.003	0.010	0.007
Systems Engineering	0.027	0.014	-0.013
Other Technical	0.008	0.005	-0.003
Technical Total	0.733	0.748	0.015
Overall Total	1	1	

Appendix O: Acquisition Manager (63AX) Observed Table

Degree	1990	2000
Acquisition/Logistics	54	39
Aeroscience Technology/Studies	27	81
Area Studies	2	3
MBA	540	466
Cost Analysis	1	9
Criminology/Forensics	1	0
Economics	9	9
Education	19	15
Engineering Management	74	72
Fine and Applied Arts	0	1
General/Liberal Studies	3	4
Geography	0	0
History	3	5
Human Resource Management	28	27
Industrial Technology	3	8
Information Resource Management	5	15
Language (Public Relations)	2	2
Military Arts and Science	0	4
Political Science	11	13
Procurement Management	7	18
Psychology	24	14
Public Administration	40	28
Social Sciences	1	0
Sociology	0	1
Space Studies	3	18
Strategic Intelligence	0	1
Systems Management/Analysis	322	178
Systems Technology, C3I	2	4
Telecommunications/Teleprocessing	1	3
Other Nontechnical	9	3
Nontechnical Total	1191	1041
Aeronautical/Astronautical Engineering	95	123
Analysis and Forecasting	1	0
Biology	3	1
Chemistry	15	10
Civil Engineering	4	1
Computer Science/Data Processing	31	39
Electrical Engineering	87	65
General Engineering	4	67
Industrial Engineering	12	30
Math/Numerical Methods in Computing	15	7
Mechanical Engineering	34	57
Meteorology	1	0
Nuclear Engineering	7	2
Operations Research	24	24
Physics	21	22
Research and Development Mgmt.	41	16
Space Operations	3	4
Systems Engineering	8	21
Other Technical	8	2
Technical Total	414	491
Overall Total	1605	1532

Appendix P: Acquisition Manager (63AX) Percentages

Degree	1990	2000	Difference
Acquisition/Logistics	0.034	0.025	-0.008
Aeroscience Technology/Studies	0.017	0.053	0.036
Area Studies	0.001	0.002	0.001
MBA	0.336	0.304	-0.032
Cost Analysis	0.001	0.006	0.005
Criminology/Forensics	0.001	0.000	-0.001
Economics	0.006	0.006	0.000
Education	0.012	0.010	-0.002
Engineering Management	0.046	0.047	0.001
Fine and Applied Arts	0.000	0.001	0.001
General/Liberal Studies	0.002	0.003	0.001
Geography	0.000	0.000	0.000
History	0.002	0.003	0.001
Human Resource Management	0.017	0.018	0.000
Industrial Technology	0.002	0.005	0.003
Information Resource Management	0.003	0.010	0.007
Language (Public Relations)	0.001	0.001	0.000
Military Arts and Science	0.000	0.003	0.003
Political Science	0.007	0.008	0.002
Procurement Management	0.004	0.012	0.007
Psychology	0.015	0.009	-0.006
Public Administration	0.025	0.018	-0.007
Social Sciences	0.001	0.000	-0.001
Sociology	0.000	0.001	0.001
Space Studies	0.002	0.012	0.010
Strategic Intelligence	0.000	0.001	0.001
Systems Management/Analysis	0.201	0.116	-0.084
Systems Technology, C3I	0.001	0.003	0.001
Telecommunications/Teleprocessing	0.001	0.002	0.001
Other Nontechnical	0.006	0.002	-0.004
Nontechnical Total	0.742	0.680	-0.063
Aeronautical/Astronautical Engineering	0.059	0.080	0.021
Analysis and Forecasting	0.001	0.000	-0.001
Biology	0.002	0.001	-0.001
Chemistry	0.009	0.007	-0.003
Civil Engineering	0.002	0.001	-0.002
Computer Science/Data Processing	0.019	0.025	0.006
Electrical Engineering	0.054	0.042	-0.012
General Engineering	0.002	0.044	0.041
Industrial Engineering	0.007	0.020	0.012
Math/Numerical Methods in Computing	0.009	0.005	-0.005
Mechanical Engineering	0.021	0.037	0.016
Meteorology	0.001	0.000	-0.001
Nuclear Engineering	0.004	0.001	-0.003
Operations Research	0.015	0.016	0.001
Physics	0.013	0.014	0.001
Research and Development Mgmt.	0.026	0.010	-0.015
Space Operations	0.002	0.003	0.001
Systems Engineering	0.005	0.014	0.009
Other Technical	0.005	0.001	-0.004
Technical Total	0.258	0.320	0.063
Overall Total	1	1	

Appendix Q: Calculated Chi Square Values

Overall					
	1990	2000		Totals	
Non-Technical Graduate Degrees	33,572	22,449		56,021	a+b
Technical Graduate Degrees	7,750	5,294		13,044	c+d
Totals	41,322	27,743		69,065	
	a+c	b+d			
	177730168	axd			
	173979750	bxc			
	3750418	difference			
Test Statistic	1.1383774				

Senior Leadership					
	1990	2000		Totals	
Non-Technical Graduate Degrees	3,722	2,804		6,526	a+b
Technical Graduate Degrees	582	481		1,063	c+d
Totals	4,304	3,285		7,589	
	a+c	b+d			
	1790282	axd			
	1631928	bxc			
	158354	difference			
Test Statistic	1.8483661				

11XX					
	1990	2000		Totals	
Non-Technical Graduate Degrees	7,080	5,353		12,433	a+b
Technical Graduate Degrees	849	812		1661	c+d
Totals	7,929	6,165		14,094	
	a+c	b+d			
	5748960	axd			
	4544697	bxc			
	1204263	difference			
Test Statistic	20.011619				

Appendix Q cont.: Calculated Chi Square Values

32EX					
	1990	**2000**		**Totals**	
Non-Technical Graduate Degrees	663	416		1,079	a+b
Technical Graduate Degrees	421	383		804	c+d
Totals	1,084	799		1,883	
	a+c	b+d			
	253929	axd			
	175136	bxc			
	78793	difference			
Test Statistic	15.18905				

33SX					
	1990	**2000**		**Totals**	
Non-Technical Graduate Degrees	3,775	1,634		5,409	a+b
Technical Graduate Degrees	1,002	516		1,518	c+d
Totals	4,777	2,150		6,927	
	a+c	b+d			
	1947900	axd			
	1637268	bxc			
	310632	difference			
Test Statistic	7.750257				

61SX					
	1990	**2000**		**Totals**	
Non-Technical Graduate Degrees	239	116		355	a+b
Technical Graduate Degrees	840	522		1,362	c+d
Totals	1,079	638		1,717	
	a+c	b+d			
	124758	axd			
	97440	bxc			
	27318	difference			
Test Statistic	3.611486				

Appendix Q cont.: Calculated Chi Square Values

62EX					
	1990	2000		Totals	
Non-Technical Graduate Degrees	885	378		1,263	a+b
Technical Graduate Degrees	2,431	1,124		3,555	c+d
Totals	3,316	1,502		4,818	
	a+c	B+d			
	994740	axd			
	918918	bxc			
	75822	difference			
Test Statistic	1.161142				

63AX					
	1990	2000		Totals	
Non-Technical Graduate Degrees	1,191	1,041		2,232	a+b
Technical Graduate Degrees	414	491		905	c+d
Totals	1,605	1,532		3,137	
	a+c	b+d			
	584781	axd			
	430974	bxc			
	153807	difference			
Test Statistic	14.63818				

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REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 074-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
20-03-2001	**Master's Thesis**	Jun 2000- Mar 2001

4. TITLE AND SUBTITLE

UNITED STATES AIR FORCE GRADUATE DEGREES FROM 1990 TO 2000: A COMPARISON

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Downing, Jonathan G. Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 P Street, Building 640
WPAFB OH 45433-8865

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GLM/ENV/01M-01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

N/A

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Throughout its history, the United States Air Force has been concerned with technical graduate education. In 1947, the Ridenour Report stated the importance and need of Air Force officers with technical graduate degrees. Today, there is concern among senior Air Force leaders that there has been an erosion of these technical skills and graduate educations.

This research will examine the issues surrounding technical graduate education in the Air Force and will address the possible loss of such technical education. The results of this research provide specific statistical data and analysis on the types and numbers of graduate degrees achieved by Air Force line officers in the years 1990 and 2000.

Based on the data analysis, this study concludes that there has been no significant change in the percentage of overall technical graduate education from 1990 to 2000. There has, in fact, been a slight increase in the percentage of technical graduate degrees in the following career fields: Pilots (11XX), Civil Engineers (32EX), Communications and Information (33SX), and Developmental Engineers (62EX). All other areas examined showed no statistically significant changes.

15. SUBJECT TERMS

Air Force Research, Education, Graduate Education, Military Research, Research Management

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Major Mark Ward, AFIT/ENV
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	95	(937) 255-3636, ext 4742 Mark.Ward@afit.edu

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

	Form Approved *OMB No. 074-0188*